THURSDAY, APRIL 25, 1907.

THE DEVELOPMENT OF CHEMICAL THEORY.

A History of Chemical Theory and Laws. By M. M. Pattison Muir. Pp. xx+555. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 17*s.* net.

THIS book, as the author remarks in several places, is not intended as a history of chemistry, but as an account of the development of chemical theory, an account of attempts "to describe, to set in due order, and to connect the changes of composition and the changes of properties which occur simultaneously in systems of homogeneous substances, and the conditions under which these changes proceed." Or, as the author again expresses his intention, it is "to trace the forms which the two fundamental inquiries of chemistry have presented at different periods, to describe some of the methods which have been used to find answers to these inquiries, and to set forth the general results of the application of these methods." The two fundamental inquiries relate to the questions, "What is a chemically distinct substance?" and "What happens when chemically distinct substances interact?"

These questions are treated historically. In answer to the first, the author deals with the "recognition of homogeneous substances, and the description of chemical changes as the interactions of those substances; the marks of elements and compounds; the laws of chemical combination, the atomic hypothesis, the molecular and atomic theory; the composition of homogeneous substances—allotropy; elements which do not react; and chemical nomenclature and classification." In answer to the second question, an account is given of "the classification of homogeneous substances; acids, bases and salts; radicals, types, dualism, the unitary hypothesis; chemical equivalency; isomerism and constitutional formulæ; the hypothesis of ionisation; the periodic law; the conditions and laws of chemical change; chemical affinity; chemical equilibrium; and lastly, the elucidation of chemical reactions by measurements of physical properties."

In pursuit of this plan, the author treats first of ancient conceptions up to the year 1780; Lavoisier's systematisation is next considered; then follows a historical sketch of the doctrine of atoms, leading to the differentiation of the atom and the molecule. An account of more modern work is here introduced, in which the van 't Hoff-Arrhenius extension of gaseous laws to dilute solutions is gone into in some detail; and the conception of a molecule having been developed, allotropy is treated of as due to molecular complexity or arrangement. The inert gases of the argon group are next mentioned, and in an appendix chemical nomenclature and notation.

In the second part of his book Mr. Muir discusses the classification of substances into acids, bases, and salts; he describes the development of the theory of types and radicals, leading to chemical equivalency; and he extends these conceptions to cover the field of molecular structure, dealing with isomerism and constitutional formulæ.

The next section treats of ionisation; then follows a short account of the periodic classification. In a third section the subjects considered are chemical affinity; chemical equilibrium; the relations between the physical properties of substances and their chemical reactions, as exemplified by their optical properties and their thermal behaviour.

These subjects are illustrated by suitable extracts from the works of the investigators who forwarded the theories. Quotations from Boyle, Priestley, and Lavoisier give an idea of these authors' styles, and render clear the subject-matter which is under discussion. To give an instance:—

"To-day it is possible to recognise a certain resemblance between the saying of Stephanus of Alexandria (about 620), 'it is necessary to deprive matter of its properties in order to draw out its soul,' and the statement of Lavoisier (1789) that the object of chemistry is 'to decompose the different natural bodies . . . and to examine separately the different substances which enter into their combination.' The first statement rested on a sweeping and superficial glance over an intricate maze of occurrences, and it produced little accurate knowledge. The second statement was a result of the penetrating study of a few detached events; it was a translation of the first statement into expressions which could be directly applied to a vast number of particular phenomena, and in a few years it produced a science."

So far as possible the authors alluded to tell their own stories, and the reader's attention is directed by Mr. Muir to the salient points in their conclusions.

It is better, on the whole, to treat chemical science as Mr. Muir has treated it, in following out the history of the development of each idea, so far as that is possible, than to attempt a chronological history; the one is the philosophy of history, the other is apt to be overburdened with unconnected detail. A third plan is the biographical one; to select certain chemists who have contributed to the advancement of their science, and to show, by an account of the life-work of each, how far discovery has been furthered. There are difficulties in all methods of treatment; probably the one chosen by Mr. Muir tends most towards lucidity.

In his preface, Mr. Muir writes:—

"Some may say I have omitted much that is important, others may think I have included not a little that is trivial. In such matters a writer must use his own judgment, after he has trained it to the best of his ability."

And at the beginning of the chapter on chemical equilibrium, he says:—

"He who would describe in detail the historical development of chemical equilibrium must be a chemist, a physicist, and a mathematician; he must be a man of great learning, vast audacity, and much literary ability."

In his own judgment Mr. Muir is quite unable to attempt the task; but his estimate is too modest. It must certainly be acknowledged that he has displayed great learning and much literary ability. As to the audacity, it is for himself to judge. W. R.

NIGER DELTA NEGROES.

The Lower Niger and its Tribes. By Major Arthur Glyn Leonard. Pp. xxii+564. (London: Macmillan and Co., Ltd.) Price 12*s.* 6*d.* net.

THERE is about this book, which is undeniably interesting, a certain haziness in its preliminary observations, a lack of sharpness in its detail, in the geography and natural history, which suggests a photograph slightly out of focus. You get a general idea of the scene, but you cannot be quite sure as to the species of the trees or flowers, or whether it is horses or cows that are feeding in the distant fields. This want of exactitude is probably due to the fact that the author has seemingly allowed several years to elapse since his departure from the Niger delta before transcribing his remembrances from his notes.

The book, in its good features and in its faults, is a rather striking example of the new school of literature dealing with negro Africa which has arisen since the publication of Mary Kingsley's West African studies. This remarkable woman founded a new school in African studies which in some directions—politically more especially—has wrought much good. In convincing the British white man—official, missionary, or merchant—that the black is not the half-animal savage which many unthinking people had considered him to be, that there is much good in his native ideas of religion and social economy, Mary Kingsley came near to being a genius, for she grasped and expressed many truths about the negro of West Africa which had been perceived by those who did not write or speak, and had been overlooked by many who did both. Her gift of intuition enabled her to arrive at these conceptions with very little help from language. In her two or three years spent on the West Coast of Africa she never mastered a sentence in any African language, and all her inquiries were conducted through English-speaking interpreters. Those, therefore, who have had more scientific training in the affairs of Africa cannot always bring themselves to agree with Miss Kingsley's statements or with the deductions drawn therefrom; but she carries conviction in so much of her work that it is not necessary to attack it as a whole. In a journal of exact knowledge like NATURE it is as well, however, to put ethnologists on their guard, to demand the utmost precision of statement from new writers on African subjects, even perhaps to beg of those writers to furnish an array of accurate and useful facts and not attempt to add their own deductions, which may be based on a very limited knowledge either of Africa or the human race in general.

Miss Kingsley's disciples are too fond of coining words in "'ism" and "'ality," and out of these they create a windy philosophy of German nineteenth-century type which they then declare to be the true meaning of African religious ideas. In one book—not that under review—much of this philosophy is based on a series of sentences in a native language, the words for which, though correctly taken down, are followed by a translation which is often incorrect and misleading. Major Leonard in one chapter has cited a number of interesting proverbs and several fables, but he does not tell us from which tribe each is drawn, and his work would have carried more conviction if he had given the actual rendering in the native language, so that specialists could have satisfied themselves as to the correctness of the translation.

There is a good deal more accuracy and definiteness in the way the author traces the history of the Ibo and Jekri and Efik peoples, and he imparts much useful and novel information regarding the Ijo tribe, which, not differing physically from the other negro inhabitants of the Niger delta, nevertheless possesses a language of very isolated type with no clear relationships. The descriptions of the native gods and the spirits who are believed to exist in trees, earth, water, and sky are valuable, and, so far as the reviewer can judge, accurate; moreover, they are given in a manner and style certain to arrest and retain the reader's interest. "Horrors" are dealt with in sober language, but some of the incidents cited might be the nucleus of powerful stories such as Grant Allen used to write. To those writers of fiction who place their stories in Africa, Major Leonard's book will supply many a sensational episode, while at the same time keeping within the limits of actual fact.

Much interesting matter is also included dealing with the languages of the Niger delta and of Old Calabar. The reviewer, however, cannot quite endorse Major Leonard's theories as to etymology and the inter-relationship of certain language groups, but these theories are presented without dogmatism, and are worth consideration.

The book is therefore interesting, and more than half of it consists of a well-presented statement of the religious beliefs, manners, and customs of the Ibo people more especially, and also of the Ijo, Jekri, Efik, and Ibibio. If Major Leonard could have omitted some of the preliminary chapters dealing too much with speculative philosophy and have confined himself to the interesting statement of his own personal observations, he would have produced a work of compact value. Even as it is, those engaged in African research will find it an excellent guide in studying the negroes of the Niger delta.

H. H. J.

PRACTICAL PLANT-PHYSIOLOGY.

Vorschule der Pflanzenphysiologie, eine experimentelle Einführung in das Leben der Pflanzen. By Prof. L. Linsbauer and Dr. K. Linsbauer. Pp. xiv+255. (Vienna: Carl Konegen, 1906.)

THIS book consists of instructions for the performance of 295 experiments in plant physiology in the widest sense. It includes, not only the physiology of nutrition and movement, but also a

section on reproduction which takes in the mechanism of pollination, asexual reproduction by means of bulbils, experiments on regeneration, on the behaviour of potato tubers, and on grafting. The instructions are well arranged, and they form, with accessory explanations, a fairly continuous whole. A useful appendix is added, in which the needful outfit in apparatus and reagents is given, together with hints on laboratory methods. The book is intended partly for the "cultivated layman" and partly for the students of the Gymnasium and Realschule. It will, however, prove useful to the teachers in English universities, as well as to others who have discovered the wisdom of making even advanced students perform for themselves elementary experiments.

We are inclined to think that the cultivated layman will be frightened by the first twenty pages of the book, which contain a large number of rough qualitative estimations of the chemical compounds occurring in plants. This is excellent for the laboratory, but is hardly readable by one who does not repeat the experiments—and we cannot imagine the cultivated layman working his way through them. This, however, is not the fault of the authors, and it is only fair to say that the book in general is far from being unreadable.

In a future edition the authors would be well advised to give scientific names, if only for the sake of foreign readers, who cannot be supposed to know what plants are meant by *Sommerwurz* or *Mauerpfeffer*. In some few cases the instructions want a little re-editing. Thus, in exp. 123, p. 82, the student is directed to compare the assimilation of a withered leaf with that of a fresh one, but he is not told that the absence of assimilation in the withered leaf is due to the closure of its stomata. The experiment is, in fact, incomplete; what is missing is a repetition of Stahl's proof that the leaves of certain plants the stomata of which do not close on withering are capable of assimilating in that condition. At p. 45 the treatment of the function of the stoma in gaseous interchange is not all that could be wished. The reader will have a singular view of Brown and Escombe's researches if his knowledge is confined to what he can learn in the present volume.

The experiments (p. 52) on the effect of freezing leaves would be more instructive if the ice-injection of the intercellular spaces were studied on a hardy plant such as ivy. In the second experiment, on p. 78, a Tropæolum leaf is recommended for use in experiments on the passage of air through vegetable membranes. But this is hardly allowable, since the leaf in question is well supplied with stomata on both surfaces.

In spite of a few oversights in its pages, we do not hesitate to recommend the work of the brothers Linsbauer to our readers. The methods prescribed are simple and trustworthy, and the book has a merit which is rare in text-books, namely, that it is obviously written with sincere interest in the problems set before the learner. F. D.

SOME RECENT MATHEMATICAL WORKS.

Space and Geometry. By Dr. Ernst Mach. Translated by Thos. J. McCormack. Pp. 148. (London: Kegan Paul and Co., 1906.) Price 5*s.* net.

Irrational Numbers and their Representation by Sequences and Series. By Dr. Henry Parker Manning. Pp. vi+123. (New York: J. Wiley and Sons; London: Chapman and Hall, Ltd., 1906.)

Auslese aus meiner Unterrichts- und Vorlesungspraxis. By Dr. Hermann Schubert. Vol. iii. Pp. 250. (Leipzig: G. J. Göschen, 1906.)

Leçons de Géométrie supérieure. By M. E. Vessiot. Pp. viii+322. (Lyons: Delaroche et Schneider; Paris: A. Hermann, n.d.) Price 12 francs.

La Géométrie analytique génerale. By H. Laurent. Pp. vii+151. (Paris: A. Hermann, 1906.) Price 6 francs.

N. H. Abel: sa Vie et son Œuvre. By Ch. Lucas de Pesloüan. Pp. xiii+169; with portrait. (Paris: Gauthier-Villars, 1906.) Price 5 francs.

Theory of the Algebraic Functions of a Complex Variable. By Dr. John Charles Fields. Pp. vii+186. (Berlin: Mayer and Müller, 1906.)

Recherches sur l'Élasticité. By P. Duhem. Pp. 218. (Paris: Gauthier-Villars, 1906.)

IF reform of mathematical teaching is to mean anything real, it is necessary that the teacher should possess a much more extended survey of his subject than is conveyed in the ordinary English text-book. There could be no more suitable book for giving the elementary or secondary teacher some intelligent ideas about geometry than Dr. Mach's series of essays. In them the subject is treated in its physiological, its psychological, and its physical aspects.

The first essay thus deals with the relation of the spatial concept to the senses. In the second we have an attempt to trace the natural development of geometry from psychological causes, while the last essay discusses the subject from the point of view of physical inquiry. Incidentally, a number of illustrations are introduced, some of which are admirably adapted for teaching purposes. There could not be a better object-lesson in the elementary properties of Euclidean space than the indefinitely extended pavement formed of equal and similar triangles discussed on p. 59. From it can be read off all the principal properties of parallels and parallelograms, the relation between the three angles of a triangle, and also the main properties of similar triangles the sides of which are commensurable.

Dr. Manning's book on irrational numbers contains a presentation in a simple form of another field of mathematical inquiry, such as is also eminently suited for placing in the hands of the ordinary schoolmaster. We have decided that the geometry of proportion shall be taught to schoolboys without reference to irrational quantities, but we have not yet eliminated a spirit of reckless extravagance in the quite unnecessary use of infinite series, often with total disregard for their convergency. In Dr. Manning's treatment an irrational number is defined

as forming a point of separation between rational numbers of two classes, the numbers of one class being less than those of the other. This definition appears to involve the assumption (pp. 7, 10, &c.) that the point of separation is unique, in other words, that there cannot be two irrational numbers which have not some rational number separating them. Perhaps this assumption may be regarded as a definition of equality of irrational numbers; in any case, the inquiring reader would find it necessary to examine more fully the references to Dedekind's and Cantor's writings given on p. 56. Once the assumption or definition is made, the representation of numbers by sequences readily follows. The theory of limits is discussed on p. 57, and in the following chapter the notion of a sequence is shown to give rise to that of a series. The remaining portion of the book is mainly devoted to the study of convergence, and includes the well-known multiplication theorem and applications to the still better-known binomial and exponential series.

Prof. Schubert is rightly regarded as an authority on the teaching of mathematics, but if this description leads the English reader to expect that the present selection of lecture notes will consist of a mere repetition of the "school geometry" and "graphs" which are being ridden to death in England to the exclusion of other equally important reforms, that reader will be greatly disappointed. Dr. Schubert has rather shown us what can be done by any teacher who will endeavour to make himself "a snapper up of unconsidered trifles." He finds, in the first place, that the determination of centres of gravity is not well treated in text-books either on mechanics or on the calculus; accordingly, this problem forms the subject of the first section. The discussion includes curves, areas, and figures of revolution, and we notice the three- and four-cusped hypocycloids, the lemniscate, the kissoid, and other well-known curves figuring among the worked-out examples. Next follows a chapter on Snellius's law of refraction. Some properties of the parabola deduced from the equation of the tangent are next discussed. Then follow certain stereometric problems, and in particular an extension of Simpson's rule for the volume of a frustum. Each of these sections deals with points which are not satisfactorily treated in existing text-books. The book concludes with some interesting problems in spherical trigonometry, in particular the "Heronic" triangle, in which the sines and cosines of the sides and angles are rational fractions. The book is interesting reading, and quite easy for anyone with an elementary knowledge of the subjects discussed, to follow.

"Leçons de Géométrie supérieure" consists of a collection of lecture notes on a course delivered in 1905–6, and transcribed by M. Anzemberger. The notes are *type-written*, not printed, and we can only wish that a similar method of procedure could be adopted with the mass of dry, uninteresting, superfluous, and wholly irrelevant details which so often occupy pages of printing in modern published "researches." The course can be precisely described to English readers as "solid geometry of curves, surfaces and complexes." It deals mainly with the large subject of curvature, but, in addition to considering systems of lines, the author gives some elegant discussions of systems of spheres and circles. The present reviewer has for some time past given a course of lectures on solid geometry in which the curvature of curves is treated kinematically. It is interesting to see this most useful and suggestive method adopted in the present notes, for example, in defining the osculating plane as the plane containing the tangent and the acceleration.

M. Laurent's book also deals with analytical geometry, mainly solid geometry, but treats principally those portions of the subject which are studied before curvature. It has for its object the development of geometry from a purely abstract point of view independently of any preconceived notions regarding space. It is thus based on the study of orthogonal transformations and quadratic forms, and an instance of the spirit of the book is afforded by the preliminary note, in which the periodicity of the circular functions is derived from their definition as exponentials apart from any consideration of their geometrical properties. The subject-matter includes the study of tangents and envelopes, the properties of surfaces of the second degree, their diameters and polars, the principle of duality, and a final chapter on the non-Euclidean spaces of Riemann and Bolyai. The author at the outset advises his readers to make a clean sweep of all their previously acquired geometrical notions. It is pointed out that in order to pass from the abstract to the concrete one definition is required, namely, the definition of rigid-body displacement. This definition is to be regarded as fundamental, and as superseding Euclid's axiom of parallels. Among the applications we notice Abel's theorem and an important theorem of Chasles.

The story of Abel's life has been told recently in more than one book, yet it is a story that well bears re-telling, if for no other reason because it ought to be read as widely as possible. It is natural that M. de Pesloüan should give considerable attention to the part of Abel's life which was spent in Paris, and in a concluding chapter he offers some reflections as to the causes which led to Abel's great memoir being neglected at the time it was offered to the academy. To understand these causes, M. de Pesloüan considers it is only necessary to study the trend of mathematical thought in Paris about the year 1826. At that time French mathematicians were too much engrossed with applied mathematics—such as dynamics and electricity—to give heed to a paper dealing with a property of transcendental functions, and thus nobody understood or appreciated the value of Abel's work. The author further cites the parallel case of Galois as another unappreciated mathematical genius who interested himself greatly in Abel's work. It might be easy to cite other examples, such as Grassmann. The misfortune is that there is nothing to prevent a recurrence at the present time of the circumstances which led to Abel's dying in poverty without obtain-

ing any adequate recognition of the work which in later days caused his name to be handed down to posterity.

Of the remaining two books on our list a great deal might be said, but it would be difficult to give more than a bare statement of their contents in a general review of the present character. Dr. Field's development of the theory of algebraic functions by algebraic methods occupies a useful place in the literature of the subject, and is well adapted for use as an introductory treatise. In the matter of exposition, the summaries at the commencement of each chapter are valuable. The subject-matter includes a discussion of the Riemann-Roch theorem, Plücker's formulæ, and the Abelian integrals. The development of the theory, which is applicable to algebraic equations of the most general character, culminates in the complementary theorem, from which such applications as those just mentioned follow as corollaries.

Prof. Duhem's treatise has for its object the study and analytical expression of the equations of a material medium for displacements and stresses of a more general character than those considered in the ordinary analysis of stresses and small strains. It thus takes account of finite strains and of viscous in addition to elastic resistances. It includes the study of isothermal and adiabatic changes. The problem of wave propagation is discussed at considerable length, and in particular the conditions for permanence of wave motion. Hysteresis is not taken into account. The problem is a generalisation of that dealt with in 1874 by Dr. Oskar Emil Meyer. Some time back a small elementary treatise was reviewed in NATURE dealing with a somewhat cognate subject, namely, the classification of the various phenomena that can exist in a deformable medium, and the present treatise may be conveniently described as an analytical discussion of the x, y, and z equations, while the little book in question explained the A, B, C of the subject.

G. H. B.

OUR BOOK SHELF.

Arboriculture Fruitière. By Léon Bussard and Georges Duval. Pp. xii+562; illustrated. (Paris: Baillière et Fils, 1907.)

THE object of this little book, we are told, is to be useful to fruit-growers, and with that view to lay before the reader in a condensed but systematic form as complete a general view as possible of the scientific principles underlying practical methods of fruit culture.

The actual details of cultivation do not differ materially from those followed in this country, but there is a marked difference in the manner, and especially in the spirit, in which the several operations are carried out in the two countries.

Here the details of pruning, pinching, and the like are done in routine fashion, handed down from our predecessors and pursued because experience has shown the utility of the practice.

In France much more thought is given to the matter. The book before us affords an instance of this. The various shapes and positions which the buds assume and the circumstances in which they are formed are gone into with much detail, and we have descriptions of *lambourdes, dards, brindilles, cochonnets, bouquets de mai, chiffons, coursons,* and *bourses,* for many of which we have no corresponding terms in English. Nevertheless, a knowledge of these details is essential to a rational system of pruning, and apart from their practical interest they should be carefully studied by those interested in bud-variation and "mutation."

We do not think that botanists in general adequately recognise the great diversity that exists in the buds of a single tree. The study of a pear-branch or of a peach-shoot would form an excellent preliminary exercise to the investigation of bud-variation, and perhaps serve to restrain premature theoretical pronouncements. For this reason, apart from its practical utility, we can commend the work before us as well thought out and carefully written. The principal varieties are described, the illustrations are appropriate, there is a table of contents, and an index, the latter not so complete as it should have been.

Physikalische Kristallographie vom Standpunkt der Strukturtheorie. By Ernst Sommerfeldt. Pp. vi+132. (Leipzig: C. Tauchnitz, 1907.) Price 6 marks.

THE title of this book is somewhat misleading. According to the commonly accepted nomenclature of crystallography the book would be described as a geometrical account of the structure-theory with a few physical applications. The ground covered is hardly wide enough to warrant the name "physical crystallography."

The author's style and method are obviously modelled on those of Sohncke. His account of the 230 possible types of crystal-structure is descriptive rather than logical, and will appeal far more to a practical crystallographer who wishes to have some slight acquaintance with modern developments of the structure-theory than to a mathematician who regards the subject as an application of the group-theory. The latter will probably feel a little irritated at the absence of exactness in definition and completeness in proof. For instance, the "space-partitions" on which the argument is based are nowhere clearly defined, and the reason given (p. 65) for assuming fifteen of these partitions as fundamental is quite unconvincing. Surely the partitions should either be limited to the fourteen possible space-lattices or be extended to include such figures as Kelvin's fourteen-walled cell. Sohncke's systems are illustrated by photographs of excellent models, but such diagrams probably convey very little to a reader unless they are arranged for stereoscopic use. The author gives, however, figures showing the projections of these models on a plane, which will doubtless be an assistance to the student, though they might with advantage be clearer.

The last forty pages of the book are devoted to a discussion of some physical applications of the structure-theory. Here the author appears at his best, and has some very interesting things to say on the subject of etched figures and rotatory polarisation. His suggestions on etching of low symmetry seem to be new; those on rotatory structure, twinning, &c., are to be found in other books, but the author has brought the argument well up to date. All this part of the treatise is well worth reading, except that in the chapter on crystals with a trigonal axis the real point at issue is a little obscured.

H. H.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Electrical Method of Extracting Soot from Air in Flues.

ABOUT two years ago I observed that a body positively electrified to 100 volts became covered with soot in a day, while a negatively charged body remained comparatively clean.

I have reason to believe that the observation was first made by Lord Kelvin many years ago, but it does not seem to be well known.

Our laboratory mechanic, Mr. Black, has recently applied this to cleaning air by inserting in an air-flue a sheet of wire gauze connected to the positive 250-volt supply.

The electrified wire gauze is very efficient in extracting the soot from the air, and the method provides a simple means of cleaning the air supplied to large buildings in towns where the air is laden with soot.

GEORGE W. WALKER.

Physical Laboratory, The University, Glasgow, April 16.

Paradoxes and Principles.

YOUR critic has written his notice of my "Paradoxes of Nature and Science" (NATURE, February 7, p. 341) without giving reasonable care to the examination of the book, and has in consequence made a damaging statement as to fact which is so extravagantly untrue that it goes far beyond the limits of fair comment.

He says that I neglect general principles in the explanation of paradoxes, and tells me how they ought to be explained, ". . . by showing that the abnormal phenomena are determined by precisely the same laws as the normal phenomena; to 'explain' why a balloon rises it is necessary to propound the general principles of gravitational mechanics and to show that it rises for the same reason as a stone falls. But Dr. Hampson eschews general principles."

This is grossly untrue. My book teems with statements of and references to general principles "propounded" in explanation of paradoxes, exactly on the system recommended to me. I have not undertaken to explain the rising of balloons—a thing not regarded by me or my acquaintances as paradoxical—but I have explained why water stands in an inverted tumbler, and have done it exactly on the lines prescribed by your critic; propounding, p. 85, the general principle of fluid pressure, "gases, like liquids, are fluids, and transmit pressure equally in all directions. The air, then, transmits in all directions the pressure due to its own weight, and it thus presses upwards beneath . . .," and, pp. 92, 107, the general principle of gravitational attraction:—"The ordinary meaning of the word 'weight' is an earthward-tending force which can be used as a measure of the quantity of material. It depends upon the mutual attraction between the material and the earth." ". . . the force . . . must vary inversely as the square of the distance in correct agreement with the law of gravitation."

A few of the many other references to general principles invoked in explanation of paradoxes are as follows:—

P. 19, "Heat makes things expand."

P. 29, "It is a general law of nature that a moving body tends to keep moving straight on at the same speed."

P. 32, ". . . resists . . . by virtue of the great law of inertia, the strong tendency possessed by all moving things to resist interference with their motion."

P. 33, "Like all other things, it tries hard to keep to its original direction of movement."

P. 78, "A fluid, when pressed upon, transmits the full pressure equally in all directions."

P. 93, ". . . its tendency at any moment is, in accordance with this law of inertia, to go straight on."

P. 97, ". . . the centrifugal force increases in proportion to the square of the velocity."

P. 116, "The general principle that weights, in descending, cannot produce more power than they consume in being raised the same height."

P. 118, "All things with which we are acquainted have some heat."

P. 149, "The principle that it requires heat energy to convert water into vapour . . ."

P. 154, "Gases and vapours are very poor conductors of heat."

P. 170, "The sudden expansion and conversion into vapour require much heat."

P. 179, "The great law of the conservation of energy . . ."

P. 212, "The doctrine that no element could by any means be changed into anything else."

P. 211, The persistence of matter, stated in sixteen lines.

If your critic does not intend to maintain the nonsensical proposition that a book for popular reading by the uninitiated should bristle with quantitative formulæ, how can he say that in writing the above and many dozens of similar passages I eschew general principles? Is this his "idea of scientific method"?

His criticism, as a guess, was, of course, not unlikely to be true of a book for such readers as I had in view. But when a critic has not time to read the book entrusted to him for judgment, would it not be fairer to the journal and to the author if he excused himself from the task of preparing a notice?

Of the value of his criticisms as to style and method, which it would take pages to discuss, I leave your readers to judge by the circumstance that the one statement capable of being definitely tested by a few quotations shows such complete carelessness about facts as to render the critic, if not malicious, certainly incompetent.

February 11. W. HAMPSON.

A SCIENTIFIC "principle" is a proposition assumed to be true universally, which is made the basis of deductions. I said that Dr. Hampson "eschewed general principles" in the sense that he does not expound these propositions or make them the basis of his "explanations."

In refutation of this statement Dr. Hampson quotes one paragraph and fourteen short sentences. (The *unquoted* reference to p. 211 is not evidence.) Presumably he considers these passages as convincing as any that he can find; certainly none could be more conclusive of the justice of my criticism. For of the fourteen sentences nine do not deal with principles at all; some of them state non-universal experimental generalisations, others particular cases of general theorems, of which no proof is offered. In the remaining five, two "principles" are mentioned, of which one, the conservation of energy, is merely named, but is nowhere propounded; the other "principle" is Newton's first law of motion.

In order to justify my contention decisively, it is really only necessary to point out (1) that for the last twenty years Newton's laws of motion have not been accepted as adequate principles of mechanics, and (2) that none of the attempts at stating the first of those laws is successful. However, I will make every possible concession and admit, for the sake of argument, that Newton's laws are "principles," and that Dr. Hampson has stated one of them. But then, where are the others? It is impossible to found mechanics on the first law alone. It is just because Dr. Hampson has neglected the second law, which introduces the conception of "force" and all its consequents, that his writings abound in confusion. Thus, in his longer quotation, which he holds up as a model of exposition, he has left the imagination of the reader to divine the nature and effects of "pressure" and "force"; it so happens that in this case the ambiguity is not serious, but elsewhere it is extremely serious. It is appalling to think in what mazes he would have entangled himself if he had not been so discreet (but inconsistent) as to omit Pascal's famous hydrostatic paradox from his list.

I repeat, then, that Dr. Hampson has attempted to explain the results of science without enunciating its principles. With fifteen quotations at his disposal he can produce no better evidence against that judgment than four inaccurate statements of a single antiquated principle which was never regarded as a sufficient foundation for even one of the many branches of physics with which he deals! THE REVIEWER.

EROSION AT NIAGARA.

IT seems to have been a matter of common observation among the early colonists of America that the Niagara Falls had receded from the escarpment at Queenston to their present position six miles up the gorge. In spite of the view then frequently held that ravines were to be accounted for by violent rendings of the crust, those six miles, even in the eighteenth century, were appealed to as a natural time-scale. It was, moreover, felt that the rate of recession might give us a measure of the antiquity of the earth. James Hall in 1842 established a series of marks and monuments to which subsequent surveys might refer, and Mr. G. K. Gilbert[1] now draws conclusions from the work of his predecessors in 1842, 1875, 1886, and 1890, and from Mr. W. C. Hall's re-examination of the edge for the United States Geological Survey in 1905. He reproduces some of Captain Basil Hall's drawings, made with a camera lucida in 1827, and interesting photographs taken from 1855 onward. The former, which appear to be of great accuracy, throw doubt on certain details of the map of 1842. Mr. Gilbert regards the survey of 1905 as of especial importance, since it is the last record of the Niagara River in a natural condition. "The Erie Canal is supplied with water from the Niagara River at Buffalo, the Welland Canal is supplied from Lake Erie, and the Chicago Drainage Canal draws water from Lake Michigan. All the water thus diverted is withdrawn from the cataract. So also is the water diverted from the river above the falls for factory purposes and for use in the generation of electricity" (p. 12).

The Horseshoe, the true head of the Niagara Gorge, about 1886. The notch in the farther margin was not present in 1827.

The really active line of erosion is at the lip of the Horseshoe Fall. Very little recession occurred here at the head of the gorge between 1827 and 1842, but the rate between 1842 and 1875 was about 4 feet per annum, and from 1875 to 1905 nearly 6 feet per annum (p. 15). "The distance through"—Mr. Gilbert writes "thru"—"which the Horseshoe Fall has retreated since it parted from the American Fall is about 2500 feet. Allowing 5 feet per annum as the rate of recession, the parting took place about five hundred years ago." The present average rate of recession of the American Fall is probably only 0·2 foot per annum.

Mr. Gilbert, in view of the importance of local and temporary conditions, such as the position of joints in the limestone shelf, wisely makes no estimate of the time that has elapsed since the falls occurred at Queenston. But his study will be welcome in the literature of geology and geography alike, since it deals with one of the most famous types of river-erosion in the world. G. A. J. C.

[1] "Rate of Recession of Niagara Falls." By G. K. Gilbert, accompanied by a Report on the Survey of the Crest, by W. Carvel Hall. Pp. 31+11 plates. (Bull. U.S. Geol. Survey, No. 306, 1907.)

A YEAR'S WORK OF THE CARNEGIE INSTITUTION.[1]

THE Carnegie Institution was founded, and endowed with 2,000,000*l.*, in order "to encourage, in the broadest and most liberal manner, investigation, research and discovery, and the application of knowledge to the improvement of mankind." The year-book for 1906 contains a general report on the work of the year, and short abstracts of the special investigations in progress. To the reader it affords abundant opportunity of "fine confused feedin'"; to the reviewer a mass of projects and results of which it is hopeless to give any adequate account.

The trustees' plan of campaign has not yet been thoroughly worked out, and, indeed, in detail at least, must vary with the time. At the outset they had hosts of applications for assistance in research. The universities and colleges of the United States are now largely staffed by men brought up on research, who find themselves without the time or the appliances for the work they have prepared themselves to do. It was natural that they should appeal to the institution for assistance, and that the trustees should respond by making grants in aid to individual investigators on a somewhat extensive scale. But difficulties have made themselves manifest, especially in the supervision of miscellaneous investigations; and experience has convinced the trustees that there is a greater prospect of a valuable return from large projects carried on under the direct supervision of the institution than from minor projects entrusted to individuals. Accordingly, during 1906, while the larger projects have been increased, a smaller number of minor grants have been made than in former years.

There are at present forty-five of these minor projects in progress. They are for the most part researches in mathematical, physical, and natural science, and in history, literature, and philology; but they include also the preparation of such works as the "Index Medicus." The grants in aid of them range from 50*l.* to 2000*l.*, and seem to be made for the provision of assistants, apparatus and materials, and for the publication of results. The total amount thus allotted during the year was about 19,000*l.*

The larger projects may be divided into four classes—astronomical, geophysical, biological, and economic and historical. Astronomy has always been

[1] Carnegie Institution of Washington. Year-Book No. 5, 1906. Pp. viii+266. (Washington: Published by the Institution, 1907.)

a favourite researching ground in America. Few of its larger universities are without observatories, and many of the smaller colleges possess them also. The institution seems to aim at extensive schemes which are beyond the scope of the universities. In the department of solar physics 28,000*l.* has been expended on the buildings and equipment of the Mount Wilson Observatory, and the year's work under Prof. Hale includes photography of the sun and of the spectra of sun-spots and flocculi, spectroscopic study of solar rotation, and bolographic study of solar absorption. It is interesting to note that, notwithstanding its princely endowment, the institution is glad to announce a gift of 9000*l.* for the provision of a mirror of 100 inches aperture for a great reflecting telescope, to be used for the analysis of the light from faint stars and nebulæ. The second astronomical department, that of meridian astronomy, has been organised in the present year, and Prof. L. Boss has been appointed, with an appropriation of 40,000*l.*, to superintend the preparation of a catalogue giving the precise positions of all stars down to the seventh magnitude. As an essential feature of the work he is to establish a temporary observatory in the southern hemisphere.

In the department of geophysics, the work has been conducted hitherto by individuals. But their investigations on the flow of rocks, the elasticity and plasticity of solids, and mineral solution and fusion under high temperatures and pressures, have been so successful that an appropriation of 30,000*l.* has been made for the purchase of a site in Azadia, D.C., and for the building and equipment of a laboratory. In another geophysical department, that of terrestrial magnetism, Dr. L. A. Bauer, with a grant of 11,000*l.*, has been carrying out a magnetic survey of the Pacific Ocean, as well as of the island of Hainan and a number of islands of the southern Pacific.

There are five biological departments. The widest in scope is that of experimental evolution, under the direction of Prof. Davenport, who has been provided with a laboratory specially designed for the study of the phenomena of heredity, hybridisation, and mutation, "by substantially the same methods as those applied to the stars by the astronomer or by the chemist to inorganic matter." The director is hopeful of success, and has already some results to report; but he points out that "a decade is the smallest convenient unit of time for measuring the progress of the more important investigations now under way." The department of marine biology is under the direction of Dr. A. G. Mayer, who has been provided with vessels, buildings, and docks, and with the aid of specialist guests is studying the fauna of the Florida coast. More novel in its aim is the department of desert botany, which has a domain and buildings in Arizona, and is directed by Dr. D. T. MacDougall. It is devoted to research on the flora of arid regions, and the influence of altitude and climate on vegetation. The director is establishing small plantations at various heights above sea-level, and denuding areas here and there that he may study their re-occupation by desert plants. He is also making systematic observations on the shores of an accidentally formed lake, 500 square miles in area, in the Salton Basin, California. The channel between the lake and the Colorado River, by the overflow of which it was formed, has now been closed, and during the gradual disappearance of the lake the re-occupation by desert vegetation of the areas left bare by the recession of the water is to be studied.

The department of horticulture is on more ordinary lines, plant, flower, and fruit development forming its scheme of work. The department of nutrition is less conventional in its character, its aim being to extend our knowledge of the physics and chemistry of normal nutrition and of the conditions and remedies for abnormal nutrition. As in previous years, its work is entrusted to individual investigators —three, working on distinct lines—at whose disposal a sum of 3000*l.* has been placed, but the provision of a special laboratory is under consideration.[1]

Finally, we have the related departments of historical research and of economics and sociology. Prof. J. F. Jameson, who directs the former, is engaged mainly in the preparation and publication of guides to the materials for American history to be found in the archives of Washington, Cuba, Great Britain, and Spain, to be extended as soon as possible to France, Mexico, and Rome, also in the publication of documents bearing upon the history of the United States. About 3000*l.* has been allotted to this department during the year. In economics and sociology, Dr. C. D. Wright and his 130 collaborators, with a grant of about 6000*l.*, have been making a bibliographic index to the public documents of the various States of the Union, and are studying population and immigration, agriculture and irrigation, manufactures, transportation, labour and industrial movements, taxation, and the negro problem, with a host of questions which these subjects suggest, ranging from railway pools to the need of church federation in Vermont.

It will be noticed that in the selection of larger projects the trustees have kept in view Mr. Carnegie's expressed wish that not merely knowledge itself, but the application of knowledge to the improvement of mankind, should be advanced. Most of the departments which have been organised have a distinct practical bearing, and some, such as the desert botany and the terrestrial magnetism departments, have blocked out work of great importance from both points of view. That the "mankind" of the articles of incorporation is being interpreted in the first instance in a somewhat local sense is natural. Charity begins at home. And it must be remembered that we are all interested in the ocean magnetic fields in which the great Republic has a special interest, that we must all benefit by a thorough knowledge of the history and the social condition of the United States, and that year by year we are all becoming more painfully affected by those abnormalities of nutrition to which the strenuous life of her citizens is supposed to give rise.

Little space remains to notice another department of the work of the institution, viz. the issue and distribution of publications. So far, fifty-seven volumes have been published, and thirty-one are now in the press. During 1906 nineteen volumes appeared, the expenditure on them being about 8500*l.* Lists of the publications are sent to about 10,000 individuals and institutions, but as the standard edition is 1000 copies only, but one-tenth of the 10,000 can be expected to respond. This restriction to 1000 copies is the most un-American feature of the policy of the institution, and in the interests of the advancement of knowledge is to be regretted. No doubt even an endowment of 2,000,000*l.* gives a limited income. But if the scientific work which it produces is of value, the publications describing the work should be widely distributed. And the president seems to take a perverse view of the question when, in order to meet anticipated criticism, he says:—"If the bibliophile has found reason for dissatisfaction in the distribution of the publications of the Institution he may be disposed to be lenient with the latter on learning that he is one of many thousands soliciting favors."

[1] Since the issue of the Year-Book it seems to have been decided upon.

AËRODYNAMICAL EXPERIMENTS AND OBSERVATIONS IN RUSSIA.

THE results of an extensive series of experiments upon the resistance of various forms of bodies in a current of air, as well as the particulars relating to various balloon ascents and observations upon the height of clouds, are given in two publications recently received from the Institut aérodynamique de Koutchino.[1] The institute (Fig. 1) was founded for the purpose of studying air resistance and for the scientific exploration of different layers of the atmosphere. Besides the director and honorary members of the staff, there are in all twenty-one men employed, of whom six are labourers.

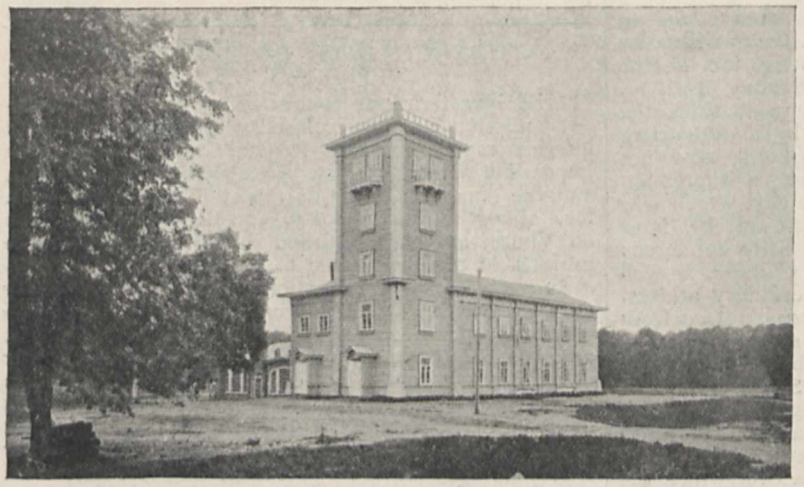

FIG. 1.—The Aërodynamic Institute at Koutchino.

The buildings and equipments cost 100,000 roubles. There is a dwelling house for the staff, a hall, 100 feet by 43 feet by 28 feet, for experimental work, and suitable workshops and tools.

The experiments upon air resistance were made in a long cylindrical tube 48 feet long and 4 feet diameter, shown in Fig. 2 (a piece of the tube is temporarily removed to show the position of a small screw inside). The air current in this tube is produced by an electric fan, the power coming in the first place from a thirty horse-power steam engine. It was found at first that the air current in the tube was not uniform, and was not even symmetrical about the axis of the tube, since greater proximity to the floor and one wall of the building produced a disturbing effect. This difficulty was overcome by inserting the end of the tube into a large cylinder 7 feet diameter and 12 feet long. The velocity of the air in the tube was carefully measured for various speeds of the fan, and subsequently the velocity for each experiment was obtained from the number of revolutions of the fan.

The weak point of this method is that the body which is being experimented upon in the tube presents an obstacle to the free motion of the air, and therefore reduces the velocity, and furthermore, the walls of the tube exert an unknown influence upon the result excepting for quite small bodies placed near the centre. With a similar arrangement at the National Physical Laboratory, Mr. Stanton found that, working with a tube of 2 feet diameter, he could not experiment upon a pressure plate of more than 2 inches diameter without finding that his results were vitiated by the influence of the walls of the tube.

It is impossible in a brief notice to give an account of all the experiments; perhaps the most important are those showing the increased lifting power which a screw possesses when a current of air is made to blow at right angles to its axis. Thus the lifting power with a horizontal current of 20 feet per second was found to be more than twice as great as with still air, although the driving power required was not increased.

Details of the methods and results of four ascents of unmanned balloons are given, and it is noteworthy that in a country like Russia the instruments should be so often recovered.

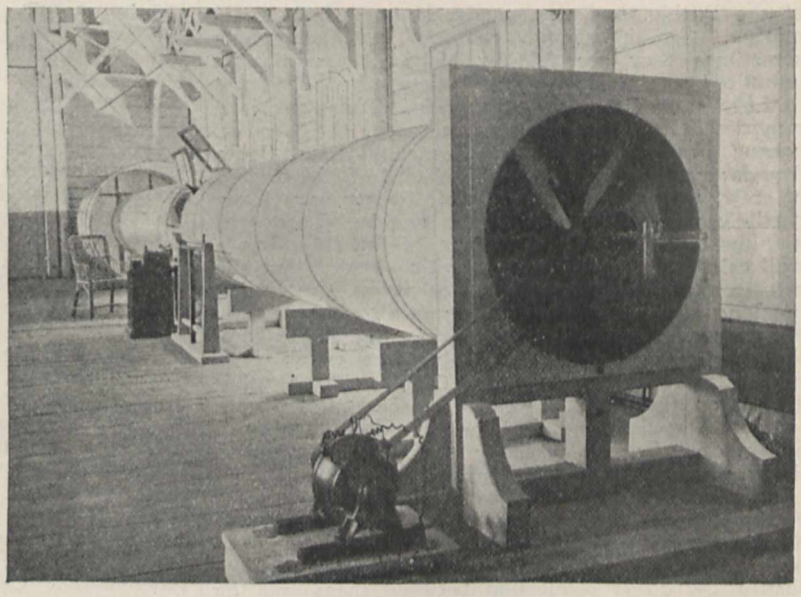

FIG. 2.—Tube for Experiments on Air Resistance at the Aërodynamic Institute, Koutchino.

The observations on clouds depend on the use of an electric search-light, and the observation, by a theodolite in the neighbourhood, of the position of the patch of lighted cloud. Unfortunately, the method can only be pursued at night, when the type of cloud is not very easy to determine.

[1] Institut aérodynamique de Koutchino. (St. Petersburg, 1905.) Bulletin de l'Institut aérodynamique de Koutchino, Fascicule I (St. Petersburg: Golicke and Wilborg, 1905.)

The whole account will well repay a careful perusal, and anyone engaged on the design of a flying machine will find much useful information in the results of the various experiments on bodies rotating in a current of air.

THE MEXICAN EARTHQUAKE.

ANOTHER great earthquake has been added to the series which has marked the recent increase in seismic and volcanic activity along the Pacific coast of America. At 11.30 p.m. on Sunday, April 14, or about 6 a.m. of April 15 by Greenwich time, the greater part of Mexico was visited by a destructive earthquake. As usual, the first accounts were not only exaggerated, but gave an erroneous impression of the distribution of damage; Mexico city, which was represented as almost destroyed, proved by later accounts to have been comparatively little damaged; while the towns of Chilpancingo and Chilapu, as well as some others not to be found in ordinary atlases, suffered great destruction. The sea-coast towns from Salina Cruz to Acapulco suffered severely, and a portion of the latter is said to have been submerged. The shock is reported as severe at San Luis Potori and Juan Batista, though no damage was done at either place; these two cities are about 530 miles apart and about 350 miles from the region of greatest damage, so we may estimate the area over which the shock was sensible as extending to somewhere about 500 miles from the centre of the disturbance.

The earliest reports stated that railway communication between Mexico city and Vera Cruz was suspended owing to the sinking of the permanent way, but this news, which has not been corroborated in later telegrams, is the only suggestion that the focus of the earthquake may have extended to any distance from the west coast. Everything else points to the conclusion that it originated close to the shore-line of the Pacific, and was partly, if not wholly, submarine. Sea-quakes are common in this region; sometimes they are felt by ships at sea though unnoticed on shore, and in at least one instance seem to have caused the loss of a ship. The story is a remarkable one. On October 3, 1902, the German barque *Freya* cleared from Manzanillo for Panta Arenas; nothing more has been heard of the captain or crew, but the ship was found, twenty days later, partially dismasted and lying on its side. There was nothing to explain the condition of the ship, but a wall calendar in the captain's cabin showed that the catastrophe must have overtaken it on October 4, not long after leaving port, as was also indicated by the anchor being found still hanging free at the bow. Weather reports show that only light winds were experienced in this region from October 3 to October 5, but, on the other hand, severe earthquakes were felt at Acapulco and Chilpanzingo on October 4 and 5, one of which probably caused the damage to the *Freya* which led to its abandonment.

Prominence has been given in the daily papers to earthquakes in Spain and Italy, which occurred shortly after the Mexican one; but they were of an order the occurrence of which is too frequent to justify any direct connection between them and the greater one. It may be different as regards the other two large earthquakes, which were registered at 9.10 p.m. on April 18, and at 0h. 11 a.m. on April 19; no news of these shocks has yet reached us; they must have been earthquakes of the first order of importance, but are only known from distant records, which are interpreted as showing that they originated at about 90° from western Europe. This is about the distance of Mexico, but it is rare for aftershocks to be of as great magnitude as these; on the other hand, it is not uncommon for earthquakes to take place in groups, usually originating at nearly opposite points in the globe. We may consequently, in the absence of news of a great earthquake in America or Japan, look for the origin of these two earthquakes in the North Pacific Ocean on the eastern part of the Malay Peninsula.

TUBERCULOSIS RESEARCH AND VIVISECTION.

THE investigations conducted by the Royal Commission on Tuberculosis, contained in a second interim report recently issued,[1] would have been impossible without the use of experiments on animals, and the appearance of this report is most opportune, for, almost simultaneously, the Royal Commission on Vivisection has published the first volume of the minutes of evidence taken before it.

As regards the investigations on tuberculosis, thirty different viruses isolated from cases of tuberculosis occurring spontaneously in bovines have been studied, and the results of introducing them into a number of different animals by feeding and by inoculation are recorded. In calves, inoculation usually results in generalised progressive tuberculosis, but the effect is somewhat dependent on the dose, *i.e.* the number of bacilli, administered. Feeding, on the other hand, usually produces lesions limited to the neighbourhood of the digestive tract, which generally retrogress and become calcareous. The bovine bacillus, when introduced into rhesus monkeys or chimpanzees either by inoculation or by feeding, induces rapid generalised tuberculosis, and considering the close relation that exists between the anthropoid apes and man, these results are of the highest importance. In pigs generalised progressive tuberculosis is readily set up both by feeding with, and by the inoculation of, bovine bacilli. Goats, dogs, and cats are relatively less susceptible, but more or less tuberculous infection can similarly be produced in them. On this part of the investigation the commissioners remark that the bacillus of bovine tuberculosis is not so constituted as to act on bovine tissues only, and the fact that it can readily infect the anthropoid apes, and, indeed, seems to produce this result more readily than in the bovine body itself, has an importance so obvious that it need not be dwelt on.

The viruses isolated from sixty cases of the disease in man have also been studied, and the results obtained show that they may be divided into two groups, subsequently referred to as group i. and group ii. The bacilli of group i. were mostly obtained from cases of abdominal tuberculosis occurring in children, and the results produced by introducing them into animals are identical with those produced by the bovine bacillus. The bacilli of group ii., obtained from various forms of human tuberculosis, grow more luxuriantly in culture than those of group i., and inoculated into calves and rabbits do not produce the generalised and fatal disease caused by the bovine bacillus, but in rhesus monkeys and in the chimpanzee set up a general tuberculosis. Certain human viruses, differing in certain respects from those of groups i. and ii., were also met with, and are classed as group iii., but an opinion on their significance is reserved for a future report.

The commissioners conclude that the tubercle bacillus in its nutritive and reproductive powers re-

[1] Second Interim Report of the Royal Commission appointed to inquire into the Relations of Human and Animal Tuberculosis, Part i., Report. Part ii., Appendix. Vol. iv., "Comparative Histological and Bacteriological Investigations." By Dr. Arthur Eastwood.

sembles other simple organisms, and that the essential difference between one strain and another depends on variations in these factors, and they therefore classify the bacilli as *dysgonic*, those that grow with difficulty on artificial media, and as *eugonic*, those that grow readily on the same media.

The bearings of the results obtained are thus summarised:—

"There can be no doubt that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis, and that in the majority of these cases the disease is introduced through cow's milk. Our results clearly point to the necessity of measures more stringent than those at present enforced being taken to prevent the sale or the consumption of tuberculous milk." The details of the various experiments are published in the appendix, in which Dr. Eastwood gives a full description of the histology of the lesions in the various animals inoculated, and of the bacteriology of the bacilli isolated from them, together with the methods employed. This appendix is a volume of 300 pages, illustrated with tables and charts, and must rank as a first-rate piece of work. Dr. Eastwood concludes that there is an essential unity, not only in the nature of the morbid processes induced by human and bovine tubercle bacilli, but also in the bacteriological characters of the tubercle bacilli which cause these processes.

As regards the minutes of evidence taken before the Vivisection Commission,[1] the witnesses so far called include Mr. W. P. Byrne, C.B., who discussed the procedure of the Home Office in the granting of licences and in the administration of the present Act; Mr. G. D. Thane, Sir J. Russell, and Sir W. Thornley Stoker, the official inspectors under the Act; Mrs. K. Cook and Dr. Snow, representing anti-vivisection associations; Mr. Stockman, chief veterinary officer of the Board of Agriculture; and Prof. Starling.

As already suggested, the work of the Royal Commission on Tuberculosis, reviewed above, affords one of the most striking examples of the necessity for, and of the value of, experiments on animals, and the evidence so far given before the Vivisection Commission has brought out the fact of the scrupulous observance of the conditions of their licences by the various holders of the same, of the complete absence of that cruelty and callousness for which the experimenters have been assailed by those who advocate the abolition of vivisection, and of the absolute necessity for the experimental method in the medical and biological sciences if these are to advance. The inspectors seem agreed that there is no need for more inspection in order to check abuses. Surprise visits can be, and are, paid at any time, and what each worker is doing is known to the Home Office.

NOTES.

THE absence of official representatives of the British Government at the celebrations connected with the opening of the Carnegie Institute at Pittsburg formed the subject of questions asked in both Houses of Parliament on Monday. The replies were to the effect that our Ambassador to the United States was prevented by other engagements from attending the celebrations; and Lord Fitzmaurice added:—"I am exceedingly glad of the opportunity publicly to state how much His Majesty's Government, and our Ambassador at Washington, appreciate the importance of that occasion." In his explanation to the House of Commons Mr. Runciman said:—"Neither the German, Austro-Hungarian, French, nor Russian Embassies were represented at Pittsburg. It is understood that the Universities of Oxford and Cambridge were represented at the celebrations at Pittsburg, and on such an occasion the presence of members of the greatest educational institutions of the country would appear to be the form of representation most suitable and convenient." The explanations do not appear to us to be entirely satisfactory. That representatives of British universities were present at Pittsburg is not a circumstance for which the Government can claim any credit. If these guests of Mr. Carnegie had been asked to represent the Government on the occasion the case would have been different, but no official notice was taken of them or of the event. When every allowance has been made, the fact remains that the German Emperor took advantage of an opportunity to show his interest in the advancement of knowledge, and that the British Government failed to do so.

A MEDALLION in memory of the late Pierre Curie, by M. Vernier, has been placed on the wall of his laboratory at the École municipale de Physique et de Chemie, Paris.

ON May 6, 8, and 10, Prof. W. Wright will deliver three Hunterian lectures of the Royal College of Surgeons on "The Prehistoric and Early Historic Inhabitants of England."

DR. G. O. SMITH has been appointed director of the U.S. Geological Survey to fill the vacancy caused by the election of Dr. C. D. Walcott to the secretaryship of the Smithsonian Institution.

ON Saturday next, May 4, Prof. W. C. McIntosh will begin a course of two lectures at the Royal Institution on "Scientific Work in the Sea Fisheries." The Friday evening discourse on May 3 will be delivered by Sir James Crichton Browne, on "Dexterity and the Bend Sinister," and on May 10 by Signor Comᵉ Giacomo Boni, on "Recent Excavations on the Forum Romanum, and the Forum Ulpium."

THE death is announced, on Saturday, April 13, of Mr. C. L. Griesbach, C.I.E., formerly director of the Geological Survey of India. Born in Vienna on December 11, 1847, he was educated in the university of that city. Afterwards coming to England, he was appointed to the Geological Survey of India in 1878, made director of it in 1894, and retired from the post in 1903. His most important geological work was done beyond the frontiers of British India, and especially in Afghanistan, which he visited first with the Canadian field force in the Afghan war, again with the Afghan Boundary Commission in 1884–6, and for a third time as adviser to the Amir in 1888–9. His descriptions are still the only available sources of information regarding the geology of much of the country seen by him on these occasions. The popular idea, that a desire to avoid military service is the reason why foreigners settle in this country, was not borne out by Mr. Griesbach, who joined the British Army shortly after his arrival in England, saw active service in Candahar, was mentioned in despatches, earned war medals and clasps, and was made a C.I.E. for his services with the Afghan Boundary Commission.

WE regret to learn of the death, on Saturday last, of Mr. George E. Davis, the founder and editor of the *Chemical Trade Journal*. Mr. Davis was one of the original fellows, and subsequently a member of council, of

[1] Royal Commission on Vivisection. Appendix to First Report of the Commissioners. Minutes of Evidence, October to December, 1906.

the Institute of Chemistry, a fellow of the Chemical Society, and he took a prominent part in the inauguration of the Society of Chemical Industry, filling in succession the offices of honorary secretary, member of council, chairman of the Manchester section, and vice-president. Mr. Davis contributed largely to chemical, technological, and microscopical literature. His "Handbook of Chemical Engineering" was published in 1901, and his other collected works include "Sizing and Mildew in Cotton Goods" (written in conjunction with Dr. Dreyfus and Mr. Philip Holland), "The River Irwell and its Tributaries" (of which he was co-author with his brother, Mr. Alfred R. Davis), and numerous other miscellaneous pamphlets, lectures, &c. From its commencement in 1887 he acted as editor-in-chief of the *Chemical Trade Journal*. Mr. Davis was in his fifty-seventh year.

AFTER a sojourn of nearly a quarter of a century in Brazil, Dr. E. Goeldi has felt it necessary to resign the directorship of the museum which now bears his own name at Pará. He is succeeded by his colleague, Dr. J. Huber, who has hitherto had charge of the botanical section. The State Government of Pará has issued an appreciative notice of Dr. Goeldi's services in connection with the museum.

WE have received a copy of the *Photographic Monthly* for April, which contains reproductions of Mr. J. P. Millar's photographs of young cuckoos in the act of ejecting their fellow-occupants of nests. Most, if not all, of these pictures have already appeared in a little work by Mr. W. P. Westall, which has been noticed in our columns.

THE aphides of the genus Chermes infesting conifers in Colorado form the subject of the first article in the Proceedings of the Philadelphia Academy for the current year. Several species occur which have life-histories of the same general type as that of the European *Chermes abietis*, both hibernating and migratory females being produced. New and other orthopterous insects from Arizona are described by Mr. J. A. G. Rehn in the second article.

TWO important articles are contained in the issues of *Biologisches Centralblatt* for March 15 and April 1, the one, by Dr. Max Wolff, on the spinal cord of the lancelet, and the other, by Mr. A. Mordwilko, on the biological relationship existing between ants and plant-lice. In the former attention is specially directed to the morphology and genesis of the cord, certain very remarkable conclusions being reached with regard to the origin of its central canal. The nature of "symphilism" and its relation to parasitism is discussed in the latter.

AMONG the contents of vol. xli., part iii., of the *Journal of Anatomy and Physiology*, special reference may be made to an article by Messrs. A. Keith and M. Flack on the form and nature of the muscular connections between the primary divisions of the vertebrate heart. One of the most important conclusions relates to the existence in mammalian hearts of a remnant of primitive fibres at the sino-auricular junction. These fibres, which are intimately connected with the vagus and sympathetic nerves, have a special arterial supply, and it is in them that the dominating rhythm of the heart is believed normally to arise. Considerable interest also attaches to the description, by Mr. C. A. Hill, of a female skeleton, apparently referable to the Bronze age, from a cave in Littondale, Yorkshire.

IN discussing polygamy and other mating habits among birds in the March number of the *American Naturalist*, Dr. R. W. Shufeldt refers to the imperfection of our knowledge on this subject in the case of many groups, stating, for example, that he cannot find out whether kiwis and brush-turkeys are polygamous or monogamous. Although birds may be polygamists, monogamists, or in certain conditions given to practices similar to polyandry, or even, possibly, to polyandry itself, we have no information with regard to the origin, causes, and, in most instances, the needs of these divergent habits. It is, however, more easy in many cases to explain the radical changes which take place in these respects as the result of domestication. It may be added that the author disbelieves in the existence of any close relationship between kiwis and other struthious birds, or between the latter and tinamous. "A kiwi (Apteryx)," he writes, "is no nearer an ostrich, and an ostrich to a tinamou, than a limpkin (Aramus) is to a bustard, and a bustard (Otis) to a quail (Colinus)."

IN the April number of the *Quarterly Review*, Prof. J. C. Ewart, of Edinburgh, discusses recent opinions and theories relating to the origin of the modern horse. After reviewing the early history of the horse-stem (throughout which the name Protorohippus is misspelt Proterohippus), the author states that he recognises three equine types as having existed in Europe about the close of the Glacial type, namely, the steppe, the forest, and the plateau type. Without entering into the consideration of all the characteristics of these, it may be mentioned that, according to the evidence of skulls from a Roman fort at Newstead, the forest type is distinguished by the face being placed nearly in the plane of the basicranial axis, whereas in the steppe type (to which the Mongolian Przewalski's horse is stated to conform, if, indeed, it be not the exemplar) the former is sharply bent down at an angle to the latter. According to the author, the skull of the celebrated thoroughbred "Stockwell" conforms very closely in this respect to the steppe type, and is altogether different from the plateau or Libyan type, although agreeing with the latter in the characters of the cervico-dorsal vertebræ. If such mixed features really exist in one and the same skeleton, there would seem little hope of an early settlement of the problem of the origin of the thoroughbred.

A MEMOIR on "Variation and Correlation in Ceratophyllum," by Prof. Raymond Pearl, with the assistance of Miss O. M. Pepper and Miss F. J. Hagle, has been published by the Carnegie Institution of Washington. The memoir deals, on somewhat novel lines, with the variation in the number of leaves to a whorl (and other characters), with especial reference to the laws of growth. It is shown that the mean number of leaves to a whorl y is related to the ordinal position of the whorl from the base of the branch x by a relation of the form $y = A + B.\log(x - C)$, the mean increasing rapidly at first and then more slowly. For a branch of a given order the constant A alone varies in populations from different environments, *i.e.* the means vary, but not the form of the law by which the successive whorls are differentiated. In branches of successive orders the constant B tends to increase, the mean number of leaves to a whorl tending towards the final limit with greater rapidity in secondary as compared with primary branches. The variability of the whorls decreases from the base of the branch onwards, successive whorls being produced "with ever-increasing constancy to their type, the ultimate limit towards which the process is

tending being absolute constancy," and an analogy is drawn between this law and the perfection of an action by repetition or practice. The author believes that both laws are of considerable generality, and apply to other organisms.

WRITING on the anti-opium drug in the Journal of the Federated Malay States Museums (December, 1906), Mr. L. Wray identifies the plant as *Combretum sundaicum*, and describes the method of making an infusion from the roasted twigs and leaves. This is mixed with a decoction of burnt opium, and it is possible that the latter supplies part of the curative effect. In the same number Mr. H. C. Robinson contributes a list of the birds found on the Aroa Islands, in the Straits of Malacca.

REFERENCE is made to a new klinostat—the instrument used to counteract the influence of gravity—designed by Dr. P. van Harreveld in *Recueil des Travaux botaniques Néerlandais*, vol. iii. The author tested several instruments by means of an automatic chronograph device, from which he concluded that a periodic irregularity could always be detected. This is important, since the repetition of a very weak stimulus at regular intervals is cumulative, and will in time induce curvature. The essential features of the author's klinostat are that it is weight driven, the impulses being suitably moderated, and regulation is effected by independent electromagnetic mechanism.

IN his report for the year 1905, Mr. J. H. Maiden, the director of the botanic gardens and public domains, Sydney, New South Wales, announces that the changes connected with the re-grading of the botanic garden have been completed after five years' work. Reference is made to the work of a previous director, Mr. Charles Moore, who died during the year. Among the Australian garden plants that attracted attention when flowering were *Thymalium Billardierii*, *Euroschinus falcatus*, and *Kennedya procurrens*, the last being a new introduction of New South Wales origin.

AN article by Mr. R. S. Pearson on the level of subsoil waters with regard to forests is published in the *Indian Forester* (February). Comparing the levels inside and outside forests, they are always higher outside; in an area of low rainfall the difference of levels is greater than where the rainfall is more abundant, and the level is steadier inside than outside the forest. These results are explained by the facts that the trees intercept a portion of the rain water and make a heavier demand on the water supply than agricultural crops. Sir Dietrich Brandis contributes a note on *Mastixia euonymoides*, with a figure of the stem section, and Mr. B. O. Coventry supplies photographs of the Changa Manga plantation in the Punjab, showing the cultivation of the *shisham* tree, *Dalbergia Sissoo*.

IT has been shown by Prof. G. Klebs that remarkable metamorphoses can be produced in plants by artificial methods of cultivation. His latest contribution, that was published in the *Abhandlungen der naturforschenden Gesellschaft*, Halle (vol. xxv.), gives some account of the results that he obtained. Four species of Sempervivum were selected for experiment, because abnormality of structure has rarely been recorded for the genus. The method consisted in removing the terminal inflorescences from plants that had been stimulated by heavy manuring or exposure to strong sunlight, when lateral flowers or inflorescences showing intense variation were developed. Irregularities in number and shape of the parts of the flower, changes from one part to another, and vegetative developments occurred, perhaps the most striking being the combination of staminal and carpellary structures. These and experiments with *Veronica chamaedrys* and other plants lead the author to the opinion that new *races* can arise as a result of changes in external conditions.

FROM a second memorandum on the American gooseberry mildew (*Sphaerotheca mors-uvae*), just issued by the Board of Agriculture and Fisheries, we learn that during the winter of 1906–7 the presence of the mildew in certain gardens in Worcestershire was definitely confirmed, and the cases investigated under the auspices of the Worcestershire County Council. Reports sent to the Board have shown that the extent and seriousness of the disease are much greater than was at first supposed, and in view of the increased danger of infection which arises when the mildew passes into its summer stage the Board advises all gooseberry growers to watch the plants closely during the summer months, especially those bushes which have been recently bought, in order that the disease may be detected and dealt with at the earliest possible moment. Gooseberry growers who have the least reason to suspect infection are advised to spray their bushes with a solution of liver of sulphur (potassium sulphide) from the time the leaves open until the fruit is set. A solution of half an ounce to a gallon and a half of water is recommended for the first spraying, and the strength should be increased to a solution of half an ounce to one gallon of water at the second spraying. Details as to the examination and treatment of plants in order to prevent the spread of the disease are given in the Board's new circular, which can be obtained post-free on application.

THE Bulletin of the Manila Weather Bureau for August, 1906, contains a reproduction of what is probably the only complete seismogram of the Valparaiso earthquake in existence. The distance from the centres of the North Pacific and Chilian earthquakes of August 17 was such that the disturbance due to the former had practically died out before the arrival of the latter; the first preliminary tremors commenced at 1h. 1·3m. Greenwich time, and lasted until about 1h. 21m. The instrument being a Vicentini microseismograph, with a vertical pendulum of 1·5 metres length, the third-phase waves, which give the greatest amplitude with a slow-period horizontal pendulum, are of small size, and it is largely due to this that the earlier phases of the record of the Valparaiso shock are so little complicated by the end portion of the preceding one.

THE Geological Survey of Western Australia has issued another report (Bulletin No. 24) of the special series dealing with different mineral fields of the State. The report, which covers seventy-nine pages, and the accompanying thirteen maps and twenty-six plates, represent the results of the work of Mr. C. G. Gibson in the Laverton, Burtville and Erlistoun auriferous belt, Mt. Margaret Goldfield. In Bulletin No. 25 Dr. R. Logan Jack discusses the prospects of obtaining artesian water in the Kimberley district, Western Australia. He passes in review nine distinct areas in which he anticipates more or less success in the search for artesian water.

THE richness and complexity of its deposits have given to mining in the Cobalt district of Canada special interest, and much valuable information regarding this new silver-mining district is contained in an admirably illustrated article by Mr. J. E. Hardman in the *Engineering Magazine*

(vol. xxxiii., No. 1). The first discovery of silver was made in the district in July, 1903, and the progress made since that date is described in detail. The characteristic rocks of the region are conglomerates of Lower Huronian age, through which, and sometimes through the underlying diabase, pass calciferous veins carrying metallic silver and sulphides or arsenides of silver with smaltite and niccolite, the arsenides of cobalt and nickel. The veins occur along the main lines of fracture by which the conglomerate has been shattered. As to the permanency of the deposits, very different opinions have been expressed, but with increasing experience the trend of opinion is towards a long life for the district.

IN addition to the usual record of measurements taken during the year 1906 at Epsom College, the report of the college Natural History Society for last year gives the average height, weight, and chest girth of all boys who have been measured in the ten years 1897–1906, and a chart showing average grades of development for the same period. On the whole, the average Epsom College boy would appear to be rather superior in physique than inferior to the average public-school boy. One marked exception is evident in the curves for the ages 17 yr. 10 mo. to 18 yr. 4 mo., though it must be stated that the number of observations on which the curves are based is, for these months, much smaller than the rest. Boys at Epsom College between these ages, however, during the last ten years appear to have been on a lower physical grade than at other ages. The other contents of the society's report show that excellent field work continues to be done by the members, among whom geology, botany and meteorology appear to be equally popular.

THE subject of the perception of relief was discussed in letters to NATURE of January 3 and 31 last (vol. lxxv., pp. 224 and 321), and the same question is raised in a communication received from Mr. R. T. A. Innes, of the Transvaal Meteorological Department. Mr. Innes describes a method of seeing stereoscopic pictures in relief without the use of a stereoscope, explained to him by Colonel W. G. Morris. If while steadily viewing a distant object an index finger be held before the eyes, two images of it are seen; if now the other index finger be held before the eyes also, four images will be seen. By a little adjustment of the distance of the fingers from the eye, the two central images can be superposed. The substitution of a stereoscopic picture leads to similar results, and the superposed images give the idea of relief.

MR. F. A. LINDEMANN and Mr. C. L. Lindemann, writing from Darmstadt, describe a new glass which is transparent to rays of very short wave-length. They have found that lithium biborieum, $Li_2B_4O_7$ (ordinary borax in which the sodium is replaced by lithium), when fused produces a clear glass which shows no appreciable absorption in the ultra-violet spectrum above 2000 Å. The aluminium line 1856 is distinctly visible, though somewhat weakened, if the glass be too thick. In order to determine the absorption below this a vacuum spectrograph would naturally be required, as the air absorbs any lines shorter than 1856. The refractive index for the D-line $n=1.5389$, the dispersion Δ between e and F, $\Delta=0.00847$, and $v=n-1/\Delta=63.7$. As might be expected, owing to the large percentage (82·5) of boracic acid, the dispersion toward the red side of the spectrum is fairly large, whereas that toward the violet side is very small. The glass is extremely transparent to Röntgen rays, which it lets through, roughly, ten times as well as ordinary glass. The specific gravity is 2·2; the hardness, 6. The glass can be cut and polished without difficulty. The cubical expansion coefficient (calculated from the constants of Winkelmann and Schott) is 118.10^{-7}, about half that of ordinary glass. It has been found that, as a general rule, the transparency for rays of short wave-length increases in analogous salts as the atomic weight of the metal decreases, but sufficient experimental data have not yet been obtained to warrant the publication of a definite formula.

A NEW high-tension condenser on the Moscicki principle is likely to prove a useful commercial apparatus if, after testing in practical work, it fulfils the advantages claimed for it in a very complete and interesting pamphlet which we have received from Messrs. Isenthal and Co., who are agents for the makers. A condenser made on this principle is now on view in London, and the construction is very neat and convenient, any number of condenser elements being grouped together in a battery very easily according to the voltage required. The chief advantages claimed over other condensers are the (1) strengthening of the dielectric to minimise the chances of rupture; (2) perfect contact between dielectric and armature plates; (3) prevention of local heating by means of a cooling chamber; (4) no organic substances used. These condensers have been used successfully for the protection of live wires against atmospheric discharges; wireless telegraphy; suppression of lag in alternating currents; and in X-ray work; and the construction of the condenser certainly renders it much less liable to breakdowns, which in practical work prove very serious. The opening in wireless telegraphy work alone for a condenser which can be depended upon is very great, and the new condenser will no doubt be given a thorough trial in many ways, as a practical commercial condenser has long been demanded.

A SECOND communication on anode rays is published by Messrs. Gehrcke and Reichenheim in No. 4 of the *Verhandlungen* of the German Physical Society (compare NATURE, this vol., p. 173). An arrangement of apparatus is described by means of which the phenomena produced are made very striking by using high potentials obtained with anodes permitting of more continuous working in a high vacuum. A brilliant fluorescence is observed on permitting the "rays" from the anode to impinge on a mica screen or on the glass walls of the vacuum tube. The colour of the fluorescence is the same as that of the emission spectrum of the metal present in the salt used at the anode; thus with lithium carbonate the light is reddish in colour, and in the spectroscope shows the red and orange lines of lithium. The admixture of another substance, such as graphite or zinc dust, with the salt used as anode facilitates the formation and improves the character of the rays. It is noteworthy that the anode rays cannot be produced from a cold anode, and that usually some interval elapses, during which heating occurs, after the current has been switched on before they make their appearance. The volatilisation of the salt may therefore play an important part in their production.

SINCE "synthetic" indigo was put upon the market in 1897, some uncertainty has existed regarding its tinctorial value as compared with the natural dyestuff. The makers of synthetic indigo have maintained that the only significant constituent of natural indigo is indigotin, identical with the synthetic substance, and that the other components present in the natural dye are either inert or harmful impurities. On the other hand, certain practical

dyers have held that the natural dye gives a certain richness of shade, or "bloom," which is invariably absent from goods dyed with synthetic indigo. The results of a practical dye test of the two materials, made with the object of throwing light on this disputed question, are described by Mr. Cyril Bergtheil in a report to the Bihar Planters' Association. The conditions were such as to be strictly comparable for the two materials as regards concentration of dye bath, temperature, and fabric dyed. The results obtained, working on the large scale under practical conditions and with dye baths of the same strength, were such as to uphold the objection of the dyers already referred to against the synthetic dye. Natural indigo not only gave a richer shade with the characteristic "bloom," but also actually a darker shade. The difference between the natural and synthetic material, which is hardly apparent in dyeing trials made on the small scale, appears to become of considerable importance under conditions such as exist in actual practice.

THE third fasciculus of the first volume of Prof. O. D. Chwolson's "Traité de Physique," which is being translated from the Russian and German editions into French by M. E. Davaux, and supplied with notes on theoretical physics by MM. E. and F. Cosserat, has been received from M. A. Hermann, of Paris, who is publishing the work. Two previous parts of this excellent treatise were reviewed at length in our issue for February 15, 1906 (vol. lxxiii., p. 362), and it is unnecessary on this occasion to say more than that the present part deals with the liquid and solid states of bodies, and maintains the same high standard which characterised the previous issues.

THE Chemical Publishing Co., of Easton, Pa., has just published "Inorganic Chemistry for Schools and Colleges," by Mr. J. L. Howe. The book is an enlarged and revised edition of "Inorganic Chemistry according to the Periodic Law," by Prof. F. P. Venable and Mr. Howe. The number of experiments has been increased, and prominence has been given to the applications of chemistry. The book is published in this country by Messrs. Williams and Norgate.

IN the new issue of section i. of the catalogue of Mr. Charles Baker, of High Holborn, London, microscopists will find detailed information of a great variety of microscopes and accessory apparatus.

A SIXTH edition of "The Essentials of Chemical Physiology," by Prof. W. D. Halliburton, F.R.S., has been published by Messrs. Longmans, Green and Co. The book has been subjected to a thorough revision, and many parts have been re-written in order to incorporate recent advances in the knowledge of the proteins and of the way they are utilised in the body, together with the results of other researches.

THE authorised English translation of Dr. Ludwig Jost's "Lectures on Plant Physiology," done by Prof. R. J. Harvey Gibson, of Liverpool, will be issued very shortly by the Clarendon Press. The Press also announces the second volume of Dr. Paul Knuth's "Handbook of Flower Pollination," translated by Prof. J. R. Ainsworth Davis, of Aberystwyth, containing an account of all known observations upon the pollination of the flowers of plants of arctic and temperate zones.

A THIRD edition of the late Mr. Herbert E. Wright's "Handy Book for Brewers" has been published by Messrs. Crosby Lockwood and Son. The first edition, which appeared in 1892, was reviewed in NATURE for November 24, 1892 (vol. xlvii., p. 75). In the present issue, not only has the size of the volume been increased by more than fifty pages, but very many paragraphs have been re-cast and fresh matter inserted. The work of Buchner and others on zymase has been dealt with, and a synoptic table of enzymes has been included.

A NEW edition of "The Imperial Gazetteer of India" is announced by the Oxford University Press. This may be considered as a new work rather than a new edition, and it will consist of twenty-six volumes, including a companion atlas. Apart from the historical volume and a few other chapters of the Indian Empire, the whole of this work has been written by officials in India under orders of the Indian Government, and every page has been submitted to the criticism of the several administrations or departments concerned.

OUR ASTRONOMICAL COLUMN.

COMET 1907*b* (MELLISH).—The following elements and ephemeris for comet 1907*b* have been computed by Messrs. Lamson and Frederick from places observed on April 15, 16, and 17 :—

Elements.

$T = 1907$ March $27{\cdot}56$ (G.M.T.).
$\omega = 328^\circ\ 47'$
$\Omega = 189^\circ\ 7'$ } 1907·0
$i = 110^\circ\ 12'$
$\log q = 0{\cdot}924$

Ephemeris 12h. Greenwich M.T.

1907	α h. m.	δ ° ′
April 22	7 46	+35 36
,, 26	8 4	+40 58
,, 30	8 17	+44 17

The brightness is decreasing rapidly, from 0·59 on April 18 to 0·11 on April 30, the unit of brightness being that when the comet was first discovered (mag. 11·0). The comet is now circumpolar, and is travelling through the constellation of the Lynx, in a north-easterly direction, towards Ursa Major (Kiel Circular, No. 96).

A NEW VARIABLE OR NOVA, 156.1906.—In the *Atti della Reale Accademia dei Lincei*, vol. xvi. (fifth series), p. 241 (March 3), Prof. E. Millosevich records the observations of a faint star which is certainly an interesting variable, and may prove to be a fading Nova. On November 6, 1906, the star in question was first noticed as a yellow object of magnitude 8·4, its position being

1906·0 $\alpha = 1$h. 23m. 56·59s., $\delta = +50^\circ\ 22'\ 12''{\cdot}1$.

Subsequent observations showed that the star was fading, the decrease in brightness being roughly proportional to the time, and amounting to about 0·3 magnitude in ten days. By February 26, 1907, the magnitude had decreased to 12·3, the colour, in the interval, having passed through successive stages from yellow to red to quite a ruby-red, which was still notable on February 19, when the magnitude was but 12·0.

THE ALBEDOES OF THE SUPERIOR PLANETS.—A novel method of calculating the albedoes of the superior planets is suggested by Mr. J. E. Gore in No. 382 of the *Observatory* (p. 172, April). The mass of the brighter component of α Centauri is equal to that of the sun, and their spectra are similar; thus the star may be considered as a duplicate of the sun, and Mr. Gore proposes to estimate the albedoes of the superior planets by comparing their photometric magnitudes when in opposition with that of α Centauri.

In a previous paper Mr. Gore has shown that, taking the parallax of the star to be $0''{\cdot}75$, and assuming the diameter of its brighter component to be the same as that of the sun, the apparent brightness of our central luminary is 75,232,650,000 times that of the brighter component of α Centauri.

Connecting this with the amount of sunlight inter-

cepted by the planet, the planet's mean distance and its photometric magnitude at opposition Mr. Gore evolved a formula which gave the following values for the albedoes of the several planets:—Mars, 0·2072; Jupiter, 0·595; Saturn, 0·6744; Uranus, 0·61; and Neptune, 0·6276.

THE SECOND GLOBULAR CLUSTER IN HERCULES, MESSIER 92.—No. 3, vol. viii., of the *Astronomiska Iakttagelser och Undersökningar å Stockholms Observatorium* is devoted to a discussion, by Dr. Karl Bohlin, of the measures of a plate showing the cluster Messier 92, taken at Stockholm on April 29, 1898. The conditions of measurement and the corrections applied are discussed in full, the actual measures being tabulated. The number of stars considered is three hundred and forty-eight, and of each of these the position and magnitude for 1898·0 are given. In a third table the resulting places are compared, for twenty-nine stars, with those obtained from measures made at Upsala in 1873, and the apparent proper motions deduced. A diagram given at the end of the volume shows these proper motions graphically, the greatest differences (Stockholm-Upsala) being $\Delta\alpha = +6''\cdot6$ and $\Delta\delta = -4''\cdot6$, whilst the mean values are $+1''\cdot5$ and $-1''\cdot7$ respectively.

HALLEY'S COMET.—*Knowledge and Scientific News* for March (No. 3, vol. iv., p. 57) contains an interesting article by Mr. F. W. Henkel on Halley's comet. Mr. Henkel discusses cometary phenomena and mechanics in general, showing their application in the observed appearances of Halley's famous object in particular. The apparitions are carried back as far as 1066, although the identity of the object represented on the Bayeux tapestry with that known as Halley's comet cannot yet be regarded as beyond doubt; probably the investigation now being carried out by Mr. Crommelin may settle this question. Many other interesting points, such as the perturbative action of Jupiter, the existence of an interplanetary resisting medium, and the various features presented by Halley's comet at previous apparitions, are dealt with in a very simple manner in Mr. Henkel's paper.

ECLIPSES OF JUPITER'S SATELLITES, 1878–1903.—The results of the photometric observations of the eclipses of Jupiter's satellites, carried out at the Harvard College Observatory between June 23, 1878, and the end of 1903, are published by Prof. E. C. Pickering in part i., vol. lii., of the Annals of the Astronomical Observatory of Harvard College. The present publication contains simply the observational records in detail, with notes on the same, and a catalogue of the eclipses which were observed. The discussion of the entire material by Prof. R. A. Sampson, of Durham University, will appear in part ii. of the same volume.

RAINFALL IN GERMAN SOUTH-WEST AFRICA.[1]

IN spite of native risings and recalcitrant Parliaments, our German cousins manage to carry on meteorological observations in their African possessions, and some results of their work which are of great importance in connection with the general meteorology of South Africa have just been issued as a supplement to the official "Deutsches Kolonialblatt." In the first section of this publication Dr. Ottweiler has collected and re-printed all trustworthy rainfall records—both official and unofficial—from German South-West Africa, and, for the sake of completeness and comparison, he has added returns from a number of stations in the adjoining British and Portuguese territories. For this alone meteorologists will be grateful to him. A supplementary table giving the positions and heights of the stations, and in most cases a brief description of the orographical features of the country surrounding them, will also be welcome.

As is to be expected in so "young" a country, the material collected is far from homogeneous, and, moreover, most of the stations are of very recent date. The author thus had before him the task of "weighting" the means deduced from the observations to render them approximately comparable among themselves before proceeding to discuss results. The process is not entirely satisfactory, but unless we are to refrain from drawing conclusions until a homogeneous body of statistics is available, some manipulation of the figures is necessary.

The results, which are illustrated in a number of admirable plates, are of exceptional interest, though they will be disappointing to those concerned with the economic development of the country. The coastal districts may be described as practically rainless, which is remarkable, as the prevailing winds are southerly or south-westerly throughout the year, and the land rises tolerably rapidly. In most parts of the world, sea breezes blowing on to rising land yield a copious rainfall, but on the coast of German South-west Africa the air is derived from higher and colder latitudes, and, as it blows over the cold Benguela current before it reaches the land, it contains little moisture when it commences its forced ascent. The heating effect of the sun far outweighs the dynamical cooling due to the ascent, and the condensation stage is never reached. Practically the only moisture which reaches the land near the coast is derived from the heavy fogs, which in winter are of almost daily occurrence. The winter rainfall, which is so prominent a feature in the west of Cape Colony, does not extend north of the Orange River.

In the more eastern inland districts the dry south-west wind prevails throughout the winter, and this portion of the year is accordingly rainless. In summer the wind shifts to the eastward, and a limited amount of moisture manages to reach the country from the Indian Ocean. In the neighbourhood of Windhuk the average annual rainfall is about 12 inches or 14 inches, and in the extreme north-east of the colony it exceeds 26 inches.

When the details of this fall are examined its value for economic purposes is found to be but small. Great fluctuations occur in the annual totals, which are of all the more importance, as the amounts are so small. Thus in the country round Windhuk the fall during the last twenty years has fluctuated between 47 per cent. and 210 per cent. of the average. Further to the south, conditions are considerably more unfavourable.

Great variability in the annual rainfall is not the only disadvantage from which the country suffers. Almost all the rain falls in thunderstorms, and torrential downpours are the rule rather than the exception. A single, though by no means isolated, instance will suffice to give an idea of the prevailing conditions. At Udabis in the year 1900 the total rainfall was 9·5 inches, and of this amount 6·5 inches fell in the course of three consecutive days, leaving only 3 inches to be distributed over the remaining 360 odd days.

It is interesting to compare the German results with those which have just been issued by the Governments of British East Africa and Uganda for the year 1905. In British East Africa the annual totals at thirty-three stations ranged from 16 inches to 99 inches. Only four stations experienced more than two absolutely rainless months, and in only two cases were these consecutive. A summary of totals for past years, which is appended to the report, shows considerable fluctuations in the amount. At three stations with records extending over at least eight years, the totals fluctuate from about 40 per cent. to about 150 per cent. of the mean value for this period.

From Uganda, rainfall data are given for nine stations. The totals for these varied from 37 inches to 96 inches. Only one station had an absolutely dry month. At Entebbe the year was the wettest on record. The total fall was 65·74 inches, 112 per cent. of the average for the last six years. Ten years' records (the first four incomplete) now exist for this station. During this period no absolutely dry months were experienced.

The British Empire has not yet produced a work on the meteorology of any of its possessions in tropical Africa which can be compared with that just issued in Germany, but it is gratifying to find that the Governments responsible for the administration of our share of the Dark Continent are realising the importance of meteorological observations, and of their systematic publication.

[1] Wissenschaftliche Beihefte zum deutschen Kolonialblatte. 20 Band, 1 Heft. Mitteilungen aus den deutschen Schutzgebieten; Die Niederschlags-verhältnisse von Deutsch-Südwestafrika. By Dr. F. von Danckelman. Pp. 84. (Berlin: S. Mittler und Sohn, 1907.)

THE RIVER PILCOMAYO.[1]

THE river Pilcomayo has its source in the Bolivian mountain ranges, and traverses the virgin forests of the Gran Chaco in a south-easterly direction. For nearly two hundred years the idea of utilising this river for purposes of navigation has engaged the attention of the Governments of Argentina, Bolivia, and Paraguay, in order to provide the rich regions through which it passes with an easy means of communication, and to afford an outlet by water for the natural products of the fertile zones of the eastern part of Bolivia.

The author of the report before us, who is a member of the American Society of Engineers, was appointed by a syndicate of capitalists in 1905 to conduct an expedition for the purpose of studying the navigable condition of the river, and reporting as to the possibility of rendering it fit for the passage of boats.

The exploration party consisted, besides the chief, of two assistants, a land and forest expert, storekeeper, and twenty-five men. They took with them for the purposes of transport twenty-two mules, forty-one horses, sixteen oxen, and five boats. Twenty-two bullocks were also taken for food. The expedition occupied four months.

The country traversed appears to be sparsely inhabited by Indians who, on the whole, are friendly. A colony has been established at Buena Ventura, about 560 miles up the river, which contains thirty families of colonists, with a total population, including servants, "intruders," and squatters, of 1000 souls. There are also in the district some Roman Catholic mission stations.

The river Pilcomayo discharges into the Paraguay, the depth at low water at its junctions being about 10 feet, and above this for sixty miles there are no soundings less than 19½ feet. At 120 miles the depth decreases to about 7 feet; at 150 miles there was barely 3 feet. At about 317 miles from its mouth the river is lost for ten miles in a marshy tract of country, through which there does not exist any defined channel. Beyond this tract, which constitutes an immense horizontal plane extending to "distances unknown," at 327 miles from the mouth, the river again assumes a defined channel with a depth of from 10 feet to 12 feet. This channel was explored up to the Argentine boundary at El Hito, 677 miles from the mouth. The width varies from 100 feet at the lower end, where the course is well defined, to 300 feet in the upper part.

In the lower part of the river the water is brackish and unfit to drink, owing to a number of salt springs, and in the upper river it is turbid and of a reddish colour.

To render this river navigable for barges carrying twenty-five tons and drawing 4½ feet of water, over a length of 670 miles, or about 100 miles beyond the colony of Buena Ventura, the commission advised the construction of three cuts or canals, one to avoid the marshy district and the two others two porous districts in the upper length, these cuts to have a bottom width of 33 feet with 5 feet depth of water; the construction of seventy-three locks and dams; the regulation of the channel and clearance of obstructions. The amount required to carry out these works is estimated at a sum equal to about one million of English money.

CRETACEOUS FERNS.[2]

THE author states that he approached the subject of palæobotany as a layman whose earlier training had been mainly in physics and mathematics. He set himself to collect such fragmentary remains of fossil plants as the Lower Cretaceous rocks of his neighbourhood afforded, with the intention of making an intensive study of the several genera. This first instalment of his results deals mainly with a single genus of Mesozoic ferns, to which Dunker in 1846 gave the name Hausmannia. The fronds of this genus are characterised, in some species, by the possession of a bi-lobed lamina not unlike that of the leaves of the maiden-hair tree (*Ginkgo biloba*), while in other forms the lamina is divided into several linear lobes, and bears a resemblance to the leaves of Baiera, an extinct genus of the Ginkgoales. It is, however, with the recent Indian and Malayan fern Dipteris that Hausmannia exhibits a more than superficial resemblance. Despite the unfavourable nature of the Quedlinburg rocks from the point of view of preservation of detail, Prof. Richter's industry has been rewarded by an accumulation of material which has enabled him to add considerably to our knowledge of this well-defined genus of ferns. He has instituted, on what appear to be adequate grounds, a few new species. The flora of Quedlinburg is characterised by a preponderance of ferns, which are said to form 80 per cent. of the whole; no trace of Angiosperms has been found; Conifers and Cycads are rare; while ferns are represented by the Gleicheniaceæ, Matonidium, Laccopteris, Clathropteris, Hausmannia, Weichselia, and a few fragments of the common Wealden species *Onychiopsis Mantelli*. It would seem that in these fossils we have the relics of a vegetation which flourished in a situation favourable to ferns. Ferns undoubtedly played a more prominent part in the composition of Mesozoic floras than in the floras of the present, but it is unlikely that the Quedlinburg flora as a whole was composed almost entirely of these plants to the exclusion of Lower Cretaceous Gymnosperms which are recorded from other localities.

Prof. Richter's contribution does not throw any fresh light on the nature of the sporangia of Hausmannia; he has, however, demonstrated a striking resemblance in habit to recent species of Dipteris as regards the slender rhizomes and long leaf-stalks. The author is disposed to regard the affinity between this northern Lower Cretaceous type and the Malayan Dipteris as rather less close than has been assumed by Prof. Zeiller and by the reviewer. In the absence of well-preserved sporangia, the question of degree of relationship cannot be settled; but the account given of such fragments of fossil ferns as were accessible to the author of this monograph seems to strengthen the view that the Dipteridinæ were abundantly represented in the northern hemisphere in the latter half of the Mesozoic era. In age the flora is considered to be rather younger than Wealden, and is compared with the Urgonian flora of Greenland as described by Heer. It is difficult to draw a conclusion as to geological age from the small number of types so far described, but in our opinion the Quedlinburg plants might fairly be classed with the Wealden floras of northern Germany, England, Belgium, and many other regions.

Prof. Richter has done good service to palæobotany by his thorough and scientific researches, and one may express a hope that other amateurs may follow his example and devote themselves with equal energy and success to the detailed study of the fossils of a single district.

A. C. S.

PROBLEMS OF APPLIED CHEMISTRY.[1]

THE science and art of the engineer are intimately interlaced with those of the practical chemist. The practical, as distinguished from the scientific, chemist possesses sufficient knowledge and experience to see to the working of machines and to minor repairs without calling in an engineer, save in difficult or complicated cases. In former times the chemical manufacturer learned his trade, both on the chemical and the engineering side, as far as it was indispensable, but he learned it simply "by rote," as the saying goes. To be sure, this never took place without large sums of money being thrown away, either in the form of misshapen or faulty apparatus and machinery, or of spoilt chemicals, and so on. And this happened to the unstudied "practical man," who, through family connections or by mere chance, had stumbled into chemical manufacturing, as well as to men who had studied the science of chemistry, and who desired to apply the knowledge thus gained to the execution of some well-known process, or to the working of some laboratory in-

[1] "The River Pilcomayo from its Discharge to Parallel 22° S., with Maps of Reference." By Gunnar Lange. Pp. 124. Translated from the Argentine Original. (Buenos Aires: The Meteorological Office Press, 1906.)

[2] "Beiträge zur Flora der unteren Kreide Quedlinburgs." Teil i., Die Gattung Hausmannia, Dunker, und einige seltenere Pflanzenreste. By Prof. P. B. Richter. Pp. iv+27+plates. (Leipzig: W. Engelmann, 1906.)

[1] Abridged from a discourse delivered at the Royal Institution on Friday, March 15, by Prof. George Lunge, of Zurich.

vention on a large scale. Those men who possessed a scientific foundation were, in their turn, compelled to learn the technical side of their profession by dint of practice, just as the tailor has to learn the art of making clothes and the barber the art of shaving. A man of scientific attainments had certainly, even in the olden times, a clear advantage over the mere "practical man."

But many branches of manufacturing, which undoubtedly have a chemical basis, and in which to-day a large number of chemists are actually employed, were formerly carried on in a purely empirical manner, like any handicraft, for instance, soap-making, tanning, brewing—indeed, all those industries which are connected with food—and above all, dyeing and tissue-printing. But towards the middle of the last century we perceive the commencement of a scientific treatment of those industries. Even before then, the genius of Chevreul had thrown a flood of light on the chemical behaviour of fatty substances, and Persoz followed in the domain of dyeing fabrics. The cooperation of the various arts and sciences was distinctly promoted by the technical high schools in France, Germany, and Switzerland.

In Great Britain the chemical industries had from the first taken their full share in the astounding development of all branches of industry which in this country has for several centuries enjoyed an uninterrupted peace, whilst continental Europe was lacerated by frequent wars. Thus Great Britain had a long lead in all the fields of commerce and industry.

Some of the most important of the chemical industries have, indeed, altogether originated in this country, especially that of sulphuric acid and that of chloride of lime, both of which date back as far as the eighteenth century. But it is only fair to remember that some of the most important improvements in these manufactures are due to French inventors and French men of science. To France we owe the invention of the Leblanc process, which could not be at once introduced into this country, owing to the fact that common salt was burdened with an absolutely prohibitive excise duty. The abolition of this tax in 1823 acted like the wave of a magic wand, not merely in calling into life the manufacture of alkali itself, but by giving a strong impetus to all the chemical industries connected therewith, viz. those of sulphuric, hydrochloric, and nitric acid. Almost immediately the tide of inventions and improvements set in, and a few decades later we find Great Britain absolutely dominant, not merely in the branches just mentioned, but generally in the field of inorganic chemical industries. For many years, up to 1870 about, this predominance was not seriously called into question.

In this manner inorganic chemical industry was developed in Great Britain up to the middle of last century to a greater extent than in any other country, by men like the Muspratts, Tennant, Gossage, Dunlop, Chance, and many others. Most of them were neither studied chemists nor engineers, but in their school any theoretically educated chemist could immensely profit for the work of factory-manager.

In close connection with this state of matters we find in England among the greatest inventors men who, at the outset, did not even possess a routine knowledge of the field in which they achieved their later successes, and who were altogether "outside the profession," like Walter Weldon, Henry Bessemer, Sydney Gilchrist Thomas.

Peculiar to England is also the case of William Henry Perkin, who, at the early age of sixteen, entered Hofmann's laboratory in London. Two years afterwards he discovered the colouring matter called "mauve," the forerunner of all colours produced from coal-tar; and only a year later he built a factory for producing his mauve, which at once proved a success and laid the foundation for his splendid work in after life.

One of the great problems presented to applied chemistry in the last century, at which many inventors in all industrial countries have been working, was the utilisation of "alkali-waste." The first partial success in this direction was scored in 1861 by Ludwig Mond and by Max Schaffner. One of the first patents referring to it was taken out in 1837 by Gossage. He quite rightly recognised a number of the conditions necessary for realising that reaction, but, unfortunately, not all of them. It soon became manifest that there were unforeseen difficulties not yet overcome. The missing links in the process were only discovered in 1883 and 1887, and led to the application of that process at all the Leblanc works. This final success is connected with the names of Carl Friedrich Claus and of Alexander Chance.

Many German chemists (as well as the speaker himself) at that time came to England for their practical education, for instance, Caro, Pauli, Martius, Peter Griess, and Ludwig Mond. The two last-named have permanently associated themselves with this country, whilst the three first-named, as well as many other German chemists who had found a temporary home in England, returned later on to their own country, and these very men have been in the forefront of those to whom is due the remarkable development of German chemical industry.

Formerly the German professor, as well as his students, had been frequently held up to ridicule, not merely abroad, but at home as well, as idealistic dreamers, unsuited to the wants of real life and to the requirements of trade and manufacture, and in this there was only too much truth, so long as they were not in intimate touch with men of practice. But at last an amalgamation between these two classes of men took place. Within a very few years there arose those enormous establishments at Ludwigshafen, Höchst, Elberfeld, Berlin, Darmstadt, and elsewhere, which are conducted on a scientific basis, but with the most extensive utilisation of all the attainments of manufacturing experience. Austria, France, Switzerland, Belgium, and America have all made immense strides in that direction. And what of Great Britain? Seeing that in pure science the people of Great Britain have never lagged behind *any* other nation, and that, on the contrary, the land of Newton and Faraday has been a beacon to all others at more than one epoch, there is absolutely no valid reason why she should now, or at any other time, be behind any other in the combination of science with practice.

The history of the ammonia-soda process has been directly contrary to so many others. It was invented by two Englishmen, Dyar and Hemming, in 1838, who did not succeed in the *practical* application of their invention, nor did their numerous successors meet with any better fortune. A Belgian engineer, Ernest Solvay, found the first economical solution of that problem, and the economical superiority of the ammonia over the Leblanc process soon became evident. This was brought home to English manufacturers by the success of the firm of Brunner, Mond and Co. The Leblanc process, and the enormous sums of money invested in it, seemed even then doomed to speedy extinction. But for a time, at least, this calamity was averted by the perseverance with which the British alkali makers kept making improvements in the Leblanc process. The prolongation of its life is due to the fact that in the first stage of the process an important acid is produced, which is not furnished by the ammonia process, viz. hydrochloric acid. Most of this is immediately converted into chlorine, which gas is used up for preparing bleaching powder, bleach liquors, and chlorates. Of these, bleaching powder is a British invention, made by the Glasgow chemist, Tennant; but, apart from this, the manufacture of chlorine and of all chlorine products has been put on its practical basis almost entirely by English inventors, and has been developed more extensively in this country than anywhere else in the world. But this last entrenchment of the Leblanc process is being vigorously assaulted from another quarter —by the electrolytic processes, which split up the alkaline chlorides directly, and in the simplest possible manner, into free chlorine and caustic alkali.

Even now it is only quite exceptional that, wherever the electrical current has to be produced by means of *steam*, electrochemical methods can compete with the older ones for the manufacture of what is called "heavy chemicals." Just those two European countries which are the greatest producers of coal, Great Britain and Germany, are less favoured by nature in respect of water-power than other countries which possess little or no stores of mineral fuel, as Sweden, Norway, Switzerland, France, Italy, and Spain. A very different condition of affairs

obtains in the United States, where we find the greatest coalfields combined with the greatest amount of water-power existing in any civilised country. The day will inevitably come when the coalfields will be so far exhausted that all those industries which consume large amounts of mechanical energy will be forced to emigrate to countries where water-power is abundant.

No other substitute has, as yet, been found for generating force, and, indirectly, electricity.

Even in those countries which are more favoured, the amount of water-power is by no means infinite; and, if it had to be drawn upon, not merely for motive purposes, but for the production of electricity for heating purposes, it would be found insufficient in most places. Here we are faced by one of the greatest problems of applied science, both in chemistry and in physics, a problem which will give plenty of occupation to generations of future inventors. At present we can only surmise that some solution will present itself in the shape of a direct conversion of the sun's rays into other forms of energy; but the means by which this would be practically accomplished are at present quite uncertain.

Seeing that the stock of mineral fuel upon this earth is so very limited, cannot we find means of husbanding it more than this has been done hitherto? Of the energy residing in coal, most ordinary steam-engines utilise less than 10 per cent., and even the most perfect steam-engines hardly more than 15 per cent. The conversion of pig-iron into steel, the manufacture of glass, and many other industries consume from four to twenty times, and even more, the quantity of coal required by theory. Moreover, in burning our fuel, whether it be for industrial or for technical purposes, we invariably send its nitrogen into the atmosphere, which surely contains quite enough of that commodity, the only exception being the manufacture of coal-gas. Here some of the grandest problems of applied chemistry present themselves to us—how to stop that fearful waste of fuel, and how to recover the nitrogen of the coal, if that be possible.

It is certain that we must look for the solution of these questions in the direction of converting coal into gaseous fuel. Another great stride ahead lies in the better utilisation of the waste gases from blast furnaces, in which respect the last few years have witnessed some very important improvements. All this refers merely to a better utilisation of the heating power of coal, but not to that other great task, the recovery of its nitrogen in a useful shape.

The immense importance of the problem lies in the fact that it touches our most urgent want, our supply of food. For agricultural purposes it does not make much difference whether we apply the nitrogen in the form of ammonia or of nitrates. The ammonia, apart from insignificant quantities otherwise obtained, all comes from the nitrogen of the coal, but up to about twenty years ago only that coal which was used in the manufacture of gas was made to yield ammonia, and only one-sixth of its nitrogen was obtained in this form. In the manufacture of coke, which is also a process of destructive distillation, and entirely analogous to gas making, very much larger quantities of coal are consumed. Up to about twenty years ago all the volatile by-products in the manufacture of coke were lost—that is to say, tar, gas, and ammonia. Even now, both in France and England, as well as in America, the recovery coke-ovens have found only a very limited adoption; in England perhaps 5 per cent. of the coke is made in this way, against upwards of 50 per cent. in Germany.

But that reserve is, after all, nothing like sufficient to cover the requirements of agriculture in the future, and it is quite likely that in the long run all the really available nitrogen of the coal would not suffice for the wants of man. And what about the time when coal itself will be exhausted? Well, there is an eternal and inexhaustible source of nitrogen in the atmospheric air. Four-fifths of this consists of nitrogen, calculated to amount to 4000 billions of tons. But until a very few years ago the problem of turning the atmospheric nitrogen into ammonia or nitric acid, although frequently approached in a purely scientific or, experimentally, in a technical way, had not been solved. Our days have seen the realisation of that most important task.

Let us first speak of ammonia. We must start from calcium carbide. Prof. Adolf Frank and Dr. Caro, of Berlin, found that when nitrogen is passed over red-hot calcium carbide it is absorbed with formation of calcium cyanamide. This latter, when treated with water under high pressure, is made to yield ammonia; but it is not necessary to do this, since the crude product, which they have called "lime-nitrogen," can serve directly as nitrogenous fertiliser, and is in that respect equivalent to its own weight of ammonium sulphate. The works already in operation, or in course of construction, will by the end of this year utilise water-power to the extent of some 55,000 horse-power, and will produce lime-nitrogen equivalent to 100,000 tons of nitrate of soda.

Important as ammonia is as a fertiliser, it ranks after the nitrates in that respect, and, unlike ammonia, the nitrogen of the nitrates is of immense importance for other purposes as well, viz. the manufacture of nitric acid and of explosives. These have, up to the present, been prepared almost exclusively from Chilian saltpetre. What, then, shall we do when the nitre beds of Chili are exhausted? an event which, according to most estimates, is bound to take place within thirty or forty years from now. Unfortunately, there is no tangible hope of similar beds being found in any other localities, certainly not to any great extent. The solution of *this* problem, if not altogether settled in its final shape, has now been found by means of that well-nigh omnipotent agent, electricity. At Notodden, in the Norwegian Hitterdal, a factory has been established to carry out the process of Birkeland and Eyde, who, by an ingenious application of the extreme heat produced by the electric current, make the nitrogen and oxygen of air combine to form nitric oxide, which at a lower temperature is spontaneously oxidised into nitrous vapours, with the ultimate production of nitrites or nitrates. This time there is really no doubt that a practicable and economical process has been discovered for which it is intended to employ, by the end of this year, water-power to the extent of 30,000 horse-power. The Notodden process bids fair to be followed by other even more efficient processes. The most important of these is that of the Badische Anilin- und Soda-Fabrik, for which an experimental factory is in course of construction, and for which 50,000 horse-power are to be employed.

Electricity has often been invoked to produce the most important of all inorganic products, iron. If this problem could ever be solved in an economical way, it would bring about a perfect revolution in the position of the leading nations. On the one hand, the enormous quantity of coal now consumed in the production of iron and steel (which is probably at least a quarter of the entire output of coal) would be set free for other uses, and the exhaustion of the coal-fields would be put off to a corresponding extent. On the other hand, the production of iron would pass over into the hands of those nations which command the largest amount of water-power, and which, therefore, can produce electricity most cheaply. Of the three countries which now produce between them the bulk, that is, seven-eighths, of the world's iron, Great Britain and Germany would go to the wall, and the United States, which already produce more iron than these two countries put together, would become omnipotent in that field.

One of the problems belonging to the domain of organic chemistry is the substitution of artificial for natural colouring matters. This, indeed, has now been carried out almost to the bitter end. Long ago, one of the oldest and most widely used colouring matters, that contained in madder, succumbed to the attacks of the chemists, among whom the names of Edward Schunck and William Henry Perkin testify to the glorious share taken by Englishmen in that victory. The colouring substance of madder—alizarin—is now made from English coal-tar, and has altogether taken the place of the impure form in which it occurs in the madder plant. The growers of this plant in the south of France and elsewhere have had to abandon its culture altogether, to their great sorrow.

A similar fate has already partly overtaken, and may, in the end, destroy entirely, the culture of indigo. Synthetic indigotin is now manufactured at such a low price that its competition has proved a severe blow to the indigo-planting interests. Thus the triumph of scientific investi-

gation and practical skill in chemical manufacturing, gratifying though it be as a splendid achievement of applied chemistry, is a sad trial to many thousands of Indian ryots and their British masters; and this is merely the foretaste of what will inevitably happen in many other cases. What is food for one is poison for another.

Perhaps the very greatest problem of applied chemistry is the direct production of feeding-stuffs for man and beast. The synthesis of alimentary substances from inorganic matter has, up to this moment, not been even remotely achieved, nor can we at present so much as guess the direction in which this might be done, whilst, as for the production of food from sawdust and other waste organic substances, we are in no better case. But even here the word "impossible" should not be pronounced. In a more modest form, at all events, chemistry has found magnificent scope in that quarter, viz. in the extraction of alimentary substances from new sources and in the increase of production from old ones. The colossal industry of beet-root sugar is an instance of the former, whilst agricultural chemistry, as a whole, works in the latter direction.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

COURSES of lectures, and arrangements for informal instruction, have been arranged by the Oxford University Committee for Anthropology for the coming Easter term. There will be lectures and other instruction in general anthropology, physical anthropology, psychology, geographical distribution, prehistoric archæology, technology, sociology (religion, law, custom, &c.), philology, and other subjects of interest to students of anthropology.

THE sum of 6100*l.* has been subscribed by alumni of Harvard University to establish a Shaler memorial fund in commemoration of the long services of Prof. N. S. Shaler and of the great affection in which he was held by his many students and friends. It is proposed to place a memorial tablet in the geological section of the University museum, or some other suitable place, and to use the income of the balance for the benefit of the division of geology, in support of original research and in the publication of the results of research.

ON Tuesday, April 23, the Prince and Princess of Wales visited Glasgow and opened the new buildings at the University. These buildings were erected by Principal Story's university fund, which was largely raised by the efforts of the late Principal. They form an important addition to the laboratory and lecture-room equipment of the University. They consist of two large detached institutes to the west of the main building; one provides accommodation for the departments of physiology, materia medica, forensic medicine, and the other for the department of natural philosophy. The cost of the buildings has been defrayed by subscriptions to the amount of 80,000*l.* from the citizens of Glasgow and a grant of 40,000*l.* from the Carnegie trustees. A special honorary graduation was held on the same day, at which the honorary degree of LL.D. was conferred on the Prince and Princess of Wales, the Lord Provost of Glasgow (Mr. Wm. Bilsland), the Duchess of Montrose, the Chancellor of the Exchequer, who is also Rector of the University, Right Hon. Geo. Wyndham, a former Rector, Mr. Ure, the Solicitor-General for Scotland, Sir George Watt, Sir W. R. Copland, Miss Galloway, Prof. Emile Boutroux, Prof. Norman Collie, Prof. J. H. Poincaré, Mr. Sidney Lee, Mr. D. S. MacColl, Mr. Jas. A. Reid, Mr. N. Dunlop, Prof. J. G. McKendrick, Prof. G. G. Ramsay, Prof. A. M. Stuart, and Principal Donald Macalister.

ON Saturday last, April 20, the Borough Polytechnic Institute was open for the annual inspection and display of students' work. To judge from the crowds which thronged through the building during the evening, those who live in the neighbourhood must take a great interest in this educational centre. In the chemical laboratory there was an exhibition of electrochemical apparatus, and one saw the rapid deposition of metals by means of rotating electrodes. Apparatus for measuring the absorption taking place in reduction and oxidation methods was also shown working. In the general laboratory various chemical operations were in progress, such as fractionation, steam distillation, and the like. The general public who crowded the laboratories did not, of course, understand much, but they realised that what was to them mystical chemistry might be interesting, and perhaps a few of them will become students. The recently equipped electrotechnical department, which is in the engine-room, caused a good deal of interest. Many of the fittings have been put up by the students, who also helped to build up the experimental dynamo. The engineering department is becoming very complete, and students can now carry out tests upon quite a large scale. The latest addition here is a Delaval 5 horse-power steam-turbine engine coupled on to a dynamo. Some of the metal work and wood work executed by the students was of a very creditable character, the hammered copper work being especially interesting. A noteworthy exhibit was a vernier with micrometer screw which had been entirely made—scale and all—by a lad sixteen years of age in the technical day school. The average person who passed through the institute on Saturday night would probably be most interested in the bakery and confectionery department or in the book-binding or shoe-making. All these, of course, are of great importance, and much good work is being done, but it should not be forgotten that on the scientific side, which tends above all things to the nation's advancement, good work is being done with a rather difficult material and a small staff, the chemistry department being one of the very few in Great Britain which publishes research work.

THE question of education in relation to the British Empire was considered at a meeting held in the Guildhall, London, on Tuesday, under the presidency of the Lord Mayor. The following resolutions were unanimously adopted:—(1) That in the opinion of this meeting of citizens of London and others, the education of the people of Great Britain on the subject of the Empire is deplorably backward, and that as an illustration of this fact it may be pointed out that no official map or text-book in regard to the Empire is available for teachers and the public; that in the opinion of this meeting the teaching of Empire subjects with the aid of official maps and text-books should be obligatory in all elementary and secondary schools in Great Britain, and that the Government be requested to lend official assistance in the preparation of such maps and text-books, and to sanction the permanent display of Empire maps in all schools, post-offices, and public buildings (moved by the Duke of Somerset and seconded by Dr. Parkin). (2) That a public subscription for the purpose of Empire education be inaugurated, and that the aid of the London and provincial Press and of all societies and associations, without regard to party politics, be invoked to collect funds for the purpose; that copies of these resolutions be sent to the Government, all lieutenants of counties, lord mayors, and mayors throughout the country, inviting them to call public meetings and submit thereto similar resolutions, and appeal for subscriptions to the fund (moved by Lord Milner and seconded by Mr. Deakin). (3) That the fund be called the "Empire Education Fund," and that the first trustees shall be the Right Hon. Sir W. Treloar, Lord Mayor, his Grace the Duke of Somerset, the Right Hon. Viscount Milner, P.C., G.C.B., G.C.M.G., the Right Hon. Sir Rowland Blennerhassett, Bart., P.C., and Mr. Allen H. P. Stoneham (moved by Lord Strathcona and seconded by Lord Ranfurly).

A CONFERENCE on the teaching of hygiene and temperance in the universities and schools of the British Empire was held in London on Tuesday. Lord Strathcona presided at the morning session and Sir John Gorst occupied the chair at the afternoon meeting. From the papers read it is clear that in several of our colonies and in some foreign countries much more attention is given to instruction in the laws of health than has yet been granted to it in this country. The chief object of the conference was to give prominence to this fact and to urge upon our educational authorities the importance of remedying the defect. Sir Victor Horsley, F.R.S., in an address on the method of introducing hygiene and temperance into secondary schools and universities, suggested that an

essential reform within the Board of Education is that there shall be such advice given to the Minister of Education as will enable him to grasp the principles of scientific education. It is the business of the State to see that the code and curriculum of education are arranged on a scientific and common-sense basis, and this will necessarily include the hygiene of common life and instruction in temperance. Sir Victor Horsley contended that we shall not make any headway unless we have expert advice at headquarters. It is clear that the whole system of education requires revision from a medico-scientific standpoint. The following resolutions were unanimously adopted:—(1) "That this conference has heard with great satisfaction that instruction in hygiene and temperance is systematically given in the elementary schools of the colonies of the Empire, and that there is strong evidence of the value of this teaching. While cordially acknowledging what has been already accomplished in the United Kingdom by certain educational bodies, this conference urges upon all local authorities the necessity of providing that the teaching of hygiene and temperance shall form an essential part of the whole curriculum of education of all children." (2) "This conference is of opinion that to meet adequately the responsibilities of the State towards school children, it is essential that a medical department should be instituted in the Board of Education."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 7.—"On the Combining Properties of the Opsonin of an Immune Serum." By Prof. Robert **Muir** and W. B. M. **Martin**. Communicated by Dr. C. J. Martin, F.R.S.

(1) The thermolabile opsonin of a normal serum and the thermostable opsonin of an immune serum are two distinct classes of substances. In addition to differing markedly as regards their resistance to heat, they differ in their combining relationships.

(2) The thermostable opsonin of the anti-serum investigated is a true anti-substance, and possesses the comparatively specific characters of anti-substances in general; it is left undetermined whether it has the constitution of an agglutinin or of an immune body, though certain facts point in favour of the former.

(3) Emulsions of other organisms other than the organism used in immunisation (*Staphylococcus aureus*) do not absorb the immune opsonin; on the other hand, they absorb large amounts of the normal complement-like opsonin.

(4) Powerful complement-absorbers—red corpuscles or bacteria treated with immune body or serum precipitate—have no effect on the thermostable immune opsonin, whereas they remove almost completely the labile opsonin of the normal and the immune serum alike.

Faraday Society, March 10.—Dr. T. Martin Lowry in the chair.—The potential of hydrogen liberated from metallic surfaces: H. **Nutton** and H. D. **Law**. The paper is chiefly concerned with the chemical reducing power of hydrogen when liberated from the surface of various metallic electrodes, and also the retarding action caused by the presence of small quantities of metallic salts. The metals are arranged in the following order:—mercury, lead, cadmium, tin, silver, bismuth, gold, nickel, platinum (black), the first-mentioned metal being the most capable of bringing about the reduction of a compound not readily attacked; platinised platinum, on the other hand, possesses this property in the lowest degree. Zinc as a reducer behaves in a very irregular manner; both copper and platinum (black) show a remarkable activity in the reduction of aromatic aldehydes, and iron and aluminium are variable. It was hoped by a careful study of the electrode potentials that it might be possible to differentiate between the purely chemical changes and those which were due to physical causes.—Electrode potentials in liquid ammonia: N. T. M. **Wilsmore** and F. M. G. **Johnson**. The measurements of electrode potentials in liquid ammonia were undertaken with a view to the determination of the free energy of formation of a series of metallic salts, and thereby to compare the relative affinities of the corresponding metallic elements under conditions differing as much as possible from those obtaining in the case of measurements in aqueous salutions. To this end the electrode potentials of the metals against solutions of their salts of known strength were measured against a standard electrode (cadmium in a saturated solution of cadmium nitrate). The results are given in the paper in tabular form.—The impedance of solutes in solvents as manifested by osmotic pressure: J. G. A. **Rhodin**. The author's object is to substitute for the theory of van 't Hoff, the main objection to which, in his opinion, is the direction of pressure, a theory which regards the solvent—and not the solute—as the source of the energy manifested in osmotic-pressure experiments.—The electrolytic deposition of zinc, using rotating electrodes, part ii.: Dr. T. Slater **Price**. The effect of the addition of various electrolytes on the electrolytic deposition of zinc, using a rotating kathode and the apparatus described in the previous paper, has been investigated. In all the experiments the kathode was silvered before the zinc was deposited. Excellent results were obtained, using 2 grams of sodium sulphate and 1 gram of sodium acetate for each gram of crystallised zinc sulphate, the addition of free acetic acid being unnecessary. The number of revolutions per minute of the kathode was 600–700, and the time of deposition was fourteen minutes.

Linnean Society, March 21.—Prof. W. A. Herdman, F.R.S., president, in the chair.—The origin of Angiosperms: E. A. Newell **Arber** and John **Parkin**. In attempting to trace the ancestry of this group, the authors commence by a survey of living Angiosperms with a view to determine which among them present primitive features, and also with the hope of arriving at some hypothesis as to the type of fructification possessed by the earliest members of the group. They dissent emphatically from the view generally held, and especially advocated by Engler, that the most primitive Angiosperms to-day are those with unisexual flowers, and without perianth, *e.g.* Piperales, Pandanales, &c. This conclusion is criticised on the grounds that (1) the perianth must be assumed to arise *de novo*, and to be an organ *sui generis*; (2) such plants have a sharply defined and highly complicated inflorescence, which can hardly be regarded as primitive; (3) it has so far proved barren from a phylogenetic standpoint. On the contrary, they urge the acceptance of a strobiloid theory of the angiospermous fructification on the grounds that it is typically and primitively a diplosporangiate (hermaphrodite) cone with a well-marked perianth, and one in which all the organs were originally numerous, spirally arranged, and hypogynous. It is pointed out that some of these primitive features are still retained among members of the Magnoliaceæ, Ranunculaceæ, Alismaceæ, &c. From such a cone the authors would derive by reduction the apetalous, unisexual flowers. The flower is recognised as a special type of strobilus, to which the name Anthostrobilus is given, and of which two forms can be distinguished, the one gymnospermic, the other angiospermic. Both, however, are essentially of similar construction, especially as regards the peculiar juxtaposition of the micro- and mega-sporophylls, and the presence of a perianth. The view is expressed that the "motive force," which called the Angiosperms into existence, was a radical change in the method of pollination.

Physical Society, March 22.—Prof. J. Perry, F.R.S., president, in the chair.—Experimental mathematics: Mr. **Pochin**. An instrument for describing logarithmic spirals was exhibited, and it was shown how the principal properties of logarithms and of the equiangular spiral may be established as experimental results. A spiral was described with an angle of 45°, and the positions of the radius vector, representing the first ten natural numbers, were drawn in. Cardboard sectors having been cut to fit the various angles, under the successive positions of the radius vector, it was shown that these sectors represented the logarithms of the numbers. Multiplication and division were illustrated by placing the sectors in juxtaposition, so that the angles were added or subtracted, the result being read off directly from the curve. A table of natural logarithms was also prepared from the spiral, by direct

measurement with a foot-rule and a protractor graduated in radians. A geometrical analysis was given, confirming the accuracy of the experimental results, and affording an independent proof of the exponential theorem. A second spiral was drawn with an angle $\tan^{-1} M$, thus giving common logs. in terms of the radian, and it was shown that, by using a suitably graduated protractor or modulus, one system transformed into the other. A Boucher's circle and a slide-rule were also derived practically from the spiral. The differentials $d \log_e r/dr$ and $d \log_{10} r/dr$ were shown graphically, as well as the properties of the evolute and involute.—Logarithmic lazy-tongs and lattice-works: T. H. **Blakesley.** If two straight rods, AB, CD are jointed at E, and so related that the extremities ACBD lie in the circumference of a circle, they will fulfil this condition when the angle between is changed. Suppose that AE is taken as unity, and that $ED=n$, $EC=m$, m and n being quite independent. Then $EB=mn$ as a consequence. If another pair of rods, DF, BG, similar to the first pair but bearing the ratio $n:1$ to it, be jointed at D and B to the first pair, and to the extremities FG of this pair a third pair be again jointed, and a fourth to this and so on, the ratio of each pair to the preceding one being $n:1$, the resulting linkage is called by the author a logarithmic lazy-tongs. A lazy-tongs constructed as above is said to be in the n direction. Any of the four sides AC, CB, BD, AD might be chosen as that to which the next pair of rods is to be attached, care being taken to make the ratio correspond to the direction chosen. If CB is chosen the ratio must be $m:1$, and a lazy-tongs in the direction m will result, the angular shift at each step being EAD—EDA. Suppose pairs added in the m direction to both CB and BF; then these two pairs will have, in addition to B, another common point, viz. that which is homologous to B in the m direction. In fact, the same pair is arrived at whether by moving once in the n direction and then once in the m direction, or *vice versâ*. It is clear that a joint may be added at the common point, and that the rule is a general one, hence all plane space may be occupied by such a linkage, which is called a logarithmic lattice-work. Such a lattice-work moves so that the angles at E, and points homologous, will remain equal.

Geological Society, March 27.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The southern origin attributed to the northern zone in the Savoy and Swiss Alps: Prof. T. G. **Bonney.** Prof. Lugeon, with some other eminent Continental geologists, explains certain peculiar flat folds, the higher of which sometimes project considerably beyond the lower, in the more northern sedimentary zone of the Swiss and Savoy Alps, by supposing that to no small extent the strata have been thrust forward from an original position south of the watershed of the Pennine-Lepontine Alps, overriding, as they advanced, their crest and that of the Oberland (neither having then attained its present altitude). This pressure was produced by the greater thickness of deposits of mid-Tertiary age, speaking in general terms. Prof. Sollas, in concluding a very interesting and suggestive paper on some experiments with cobbler's wax, published in the last volume of the Quarterly Journal of the society, p. 716, suggests that the results are favourable to the views of the Lausanne professor. The author takes exception to some of the cases, especially two to the east of the Simplon Pass, which are adduced by Prof. Lugeon in support of his hypothesis. It is maintained that the hypothesis receives no real support from Prof. Sollas's experiments, and involves mechanical difficulties which are practically insuperable.—The coral-rocks of Barbados: Prof. J. B. **Harrison.** The results of the author's extended, and in many places detailed, re-examination of the coral-rocks in the southern half of Barbados give no support to Dr. J. W. Spencer's theory of the existence of strata of the "Antigua formation" in that island. It is now shown that a certain knoll, whence Dr. Spencer collected corals which in his estimation proved that it and other parts of the coral-rocks were of Oligocene age, is in part made up of corals which, as stated by Prof. J. W. Gregory, "certainly show no evidence of any age greater than the Pleistocene." The author has failed to find any signs of the widespread formation, described in Dr. Spencer's paper as extending from Mount Misery to near Ragged Point, a distance of about eleven miles, and dipping south-eastward at from 12° to 20°.

Society of Chemical Industry, April 8.—Mr. R. J. Friswell in the chair.—Observations on cotton and nitrated cotton: H. **de Mosenthal.** This paper deals with the appearance of celluloses and nitrocelluloses in polarised light, their refractive indices and optical activity, as well as densities. Fourteen samples of nitrated cottons of different degrees of nitration, different solubility and viscosity, three samples of nitrated wood cellulose, and two each of nitrated ramie and flax, were examined. The appearance in polarised light was found to vary with the degree of magnification and the light used, fibres appearing differently when dry and when moistened. Various moistening liquids gave different results. The colours shown in polarised light under the same conditions seemed to be chiefly dependent on the material nitrated and the method of nitration, and they cannot be regarded as a function of the degree of nitration. The densities of celluloses and of nitrocelluloses examined were found to be higher than those recorded in text-books. The densities of the nitrated material in solution were also determined, and found to be higher than in the solid state. Observations of the refractive index of nitrated cotton in solution gave results which were not concordant, and therefore determinations were made on transparent films of nitrated cotton, ramie, and flax. The refractive index of cellulose was found by examining denitrated films and then by placing fibres in a liquid of like refraction. Atomic refractions were applied to some of the proposed formulæ for cellulose, and showed that the cellulose molecule has no double bonds.

Entomological Society, April 10.—Mr. C. O. Waterhouse, president, in the chair.—Wet- and dry-season forms of Pierinæ: Dr. F. A. **Dixey.** Specimens were shown of Pierinæ belonging to the genera Teracolus and Huphina. The exhibit was intended to illustrate the fact that in species of which the wet-season phases were very distinct from each other, the corresponding dry-season phases often could only be discriminated with difficulty.—Forms of Osphya and concurrent species: J. **Edwards.** Five forms of Osphya were shown, together with certain other species occurring at the same time and place, and, having regard to gait and appearance, resembling them more or less closely. It was not suggested that these resemblances are protective. Attention was also directed to an important function of the hind-legs of the male, namely, to secure him in position at the time of pairing.—Antennæ-joints in Trachiscelis: H. J. **Carter.** A microscopic slide prepared to demonstrate that the antennæ of the genus Trachiscelis have eleven joints, and not ten as hitherto described.—Odonata collected by Lieut.-Colonel C. G. Nurse, chiefly in North-Western India: K. J. **Morton.**—The life-history of *Cydimon* (*Urania*) *leilus*: L. **Guppy,** jun. This paper was followed by a discussion on the migration habits and classification of the species.

EDINBURGH.

Royal Society, February 18.—Dr. Robert Munro, vice-president, in the chair.—The coat colour in horses: Prof. J. C. **Ewart.** (1) The remote common ancestor of the Equidæ was probably of a reddish-brown (foxy-red) colour. (2) Horses prior to domestication probably varied in colour and consisted of (*a*) species adapted for a forest life, having dark yellow-dun coat, a broad dorsal band, and stripes more or less distinct on the face, neck, trunk, and legs; (*b*) species like Prejvalsky's horse, adapted for a steppe life, having a brown yellow or reddish-brown coat, a narrow dorsal band, but only at the most vestiges of shoulder and leg stripes; and (*c*) species adapted for a life on the plains, having a light yellow-dun coat and, in addition to a narrow dorsal band, only faint vestiges of stripes on the legs. (3) Yellow duns belonging to different varieties may, when crossed, give rise to bay and chestnut as well as yellow-dun offspring. (4) Bays obtained by crossing yellow-duns may, when crossed with pure yellow-duns, yield black and chestnut as well as bay offspring. (5) Chestnuts derived from crossing yellow-duns may, when crossed with pure yellow-duns, yield white and bay as

well as chestnut offspring. (6) When crossed with a yellow-dun a white may yield grey-roan and white-dun offspring. (7) A black, crossed with a yellow-dun, may yield either yellow-dun or black offspring.—The geology of Ardrossan: Dr. J. D. **Falconer.** A brief description is given of the geological structure of the area in the immediate neighbourhood of Ardrossan, the suggestion being made that the Upper Old Red Sandstone and overlying volcanic series were folded over an anticlinal axis striking north-west and south-east behind Ardrossan. The petrographical characters of the Carboniferous lavas and intrusive rocks are described in detail. Of the latter, the most important is the sill at Castle Craigs, more than half of which is composed of picrite. This rock passes upward into hornblende-dolerite along the whole length of the sill. The upper portion of the intrusion is fine grained and banded parallel with the upper surface, and is crossed by small pink felspathic veins. The sill affords an excellent example of the differentiation of one and the same magma into a lower basic and an upper felspathic portion. It is supposed to present considerable analogy to the banded peridotites and gabbros of Skye, and to differ from the Blackburn and Barnton picrites near Edinburgh, in which the differentiation took place entirely after intrusion.

March 4.—Prof. Crum Brown, vice-president, in the chair.—Algebra after Hamilton, or multenions: Prof. Alexander **M'Aulay.** This is a system resembling in its generality the *Ausdehnungslehre* of Grassmann, but built on the lines of Hamilton's quaternions. It differs from the *Ausdehnungslehre* in having only one method of multiplication. The theory of the "linity," analogous to the linear vector function in quaternions or to the matrix in algebra, is developed in considerable detail; also the closely connected method of differentiation, which is based upon the properties of the generalised ∇.—Note on the change produced in the conductivity and density of lead wires by permanent stretching: J. A. **Donaldson** and R. **Wilson.** The experiments were carried out in the physical laboratory of Edinburgh University. The results were negative, there being within the errors of observation no appreciable change in either the electric conductivity or the density.—The dynamical theory of seismometers: Dr. C. G. **Knott.** Some account was given of the recent important results, both theoretical and experimental, obtained by Prince Galitzin in his discussion of the theory of the horizontal pendulum, and a general discussion of earthquake records, now familiar to all students of seismology, led to the conclusion that, except for small, comparatively rapid vibrations of the ground, the amplitudes of the records could not be regarded as reproducing the motion of the ground even to a first approximation.—Temperature observations in the North Sea: Prof. D'Arcy W. **Thompson.** In this communication the author gave an account of methods and results which form a part of the second report of the North Sea Fisheries Investigation Committee. The material which formed the basis of the investigation was obtained partly from regular observations made at lighthouses and on lightships, and partly from observations, furnished twice a day, by captains of passenger steamers. From these, by graphical interpolation, fair monthly means of water temperatures on the surface and at various depths were obtained. Many interesting results were arrived at, especially with regard to the changes of temperature throughout the year and the range of annual change in different regions of the North Sea. See the Blue-book recently published by His Majesty's Government.

March 18.—Dr. R. H. Traquair, vice-president, in the chair.—The influence of temperature on the photoelectric discharge from platinum: Dr. W. Mansergh **Varley** and F. **Unwin.** The experiments were made in air, in carbon dioxide, and in hydrogen, at pressures varying, in each gas, from atmospheric pressure to a pressure of 0·0035 mm. of mercury. In air and carbon dioxide at atmospheric pressure the photoelectric currents decreased with increase of temperature up to about 400° C., after which they began to increase again. The maximum diminution in current was about 80 per cent. of the normal value. The behaviour of these two gases was identical. In hydrogen at this pressure, on the other hand, the currents steadily increased as the temperature was raised from the ordinary temperature of the air. At the lowest pressure (0·0035 mm.) the photoelectric discharge in each gas was found to increase when the temperature was raised from that of the atmosphere to 60° C. Further increase of temperature up to 400° C. produced no change in the photoelectric current. When the temperature was reduced to the ordinary temperature of the air, the sensibility of the surface gradually diminished with time, falling to half its value in about twenty-four hours. In all cases time was required for the sensibility to attain a steady value after any change in temperature.—*Spirophyllum ferrugineum*, a new genus and species of thread bacteria: D. **Ellis.** This flat, leaf-like, spirally wound organism was discovered by the author in iron-water ditches about a mile from Renfrew. The width varied from 1 μ to 6 μ according to age, and the length might reach 200 μ. The multiplication was by means of conidia, which germinated. Immediately after germination the organism had a slight motility, but this soon ceased. Before deposition of the iron the cell was semi-transparent. This new genus connects the iron bacteria, which at present are placed in the Chlamydobacteriaceæ, or thread-bacteria, with Spiromonas, a genus which must therefore be now included among the thread-bacteria.—The functions of the Rolandic cortex in monkeys: Drs. W. A. **Jolly** and Sutherland **Simpson.** The object of the experiments, which were carried out in the physiological laboratory of Edinburgh University, was to delimit accurately the motor areas in the cortex cerebri of the monkey. The method employed was a new one. The cortex was stimulated by unipolar faradisation, and the areas were isolated by the use of vulcanite plates. The sharp edges of these plates were inserted into the cortex to a depth sufficient to divide the grey matter without penetrating the underlying white substance. It was shown that the movements of muscles resulting from stimulation of the ascending parietal convolution were due to spread of current to the ascending frontal convolution. The motor centres in front of the fissure of Rolando and on the mesial aspect of the hemisphere were mapped out by application of the same isolation method.—Hydrates in aqueous solutions of electrolytes: Rev. S. M. **Johnstone.** The paper gave results of extensive series of observations of the elevation of the boiling point and lowering of the freezing point in strong solutions, with determinations of conductivities at 0° C. and 99°·4 C. In most of the curves showing the relation between concentration and elevation per gram equivalent there was a minimum point, above which elevation per gram equivalent usually increased with concentration at a gradually diminishing rate. The hydration of the molecules and ions of the solutions examined was discussed on the admittedly doubtful assumption that the ionisation could be roughly determined from conductivity data. Freezing-point and boiling-point data were found to give very similar values of the extent of hydration, the deliquescent salts giving the higher percentage hydrations. The number of molecules of water of hydration per molecule of solvent for a highly concentrated solution of a non-deliquescent salt was found in some cases to be much less than the number of molecules of water of crystallisation.

PARIS.

Academy of Sciences, April 15.—M. A. Chauveau in the chair.—Primitive tuberculosis of the lung and of the bronchial and mediastinal ganglions, communicated to young calves by the ingestion of tuberculous virus of bovine origin: A. **Chauveau.** A review of the author's communications on the subject of tuberculous infection of the lungs through the alimentary canal, with especial reference to the recent work of Calmette.—The application to pyridine of the method of direct hydrogenation by nickel: Paul **Sabatier** and A. **Mailhe.** At moderate temperatures (120° C. to 220° C.) pyridine is scarcely affected by this reaction, less than 1 per cent. being acted on. The amine formed is shown with certainty to differ from piperidine, the expected reduction product, and may possibly prove to be amylamine. If the reaction is allowed to proceed at higher temperatures, ammonia and pentane are produced in considerable quantities.—Contribution to the pathogeny of pulmonary anthracosis: S. **Arloing** and E. **Forgeot.** A controversial paper directed against the

hypothesis of Calmette, Vansteenberghe, and Grisez.—Researches on ammonium: Henri **Moissan.** The contents of a sealed letter deposited November 5, 1906. The presence of water is not necessary to the production of ammonium amalgam, since it can be produced by the interaction of sodium on the chloride or iodide of ammonium in liquid ammonia at −40° C. This reaction is, however, only possible in the presence of an excess of sodium. If the excess of sodium be removed by repeated washings with a solution of an ammonium salt in liquid ammonia, the so-called ammonium amalgam no longer exists. An account is also given of the product obtained by the electrolysis of the double iodide of mercury and ammonia in liquid ammonia.—Prof. Witz was elected a correspondant for the section of mechanics in the place of the late Prof. L. Boltzmann.—The form of the geoïd in the neighbourhood of Sahel, Algiers: MM. **Bourgeois** and **Noirel.**—A new method of regulating X-ray tubes: G. **Berlemont.** The arrangement proposed consists of an aluminium tube which can be connected at will to either the anode or kathode. The tube can be made either hard or soft in a few minutes.—The determination of the limits of inflammability of explosive mixtures of ether vapour and air: Jean **Meunier.** The lower limit of inflammability is about 75 milligrams of ether per litre of air; the upper limit is about 200 milligrams of ether per litre.—The reduction of magnesia by carbon: Paul **Lebeau.** Magnesia is reduced by carbon at the temperature of the electric furnace with the production of magnesium and magnesium carbide. Both products are in great part destroyed by the action of the furnace gases which diffuse through the carbon tubes. This gas contains much carbon monoxide, and it is known that magnesium reduces this gas with great facility.—Sulphide of aluminium and its combinations with manganese and iron sulphides: Marcel **Houdard.** Sulphide of aluminium, which is irreducible at the high temperatures of the electric furnace, forms with sulphide of manganese and sulphide of iron two double compounds, Al_2S_4Mn and Al_2S_4Fe, a description of the properties of these two substances being given.—A new chloride of tantalum: C. **Chabrié.** The new chloride is obtained by the reduction of tantalum pentachloride with sodium amalgam. Its composition is given by the formula $TaCl_3,2H_2O$, and an account is given of its chemical behaviour.—A method of synthesis of non-substituted β-ketonic amides: Ch. **Moureu** and I. **Lazennec.** The acetylenic amides, heated in alcoholic solution with a secondary amine, best with piperidine, give good yields of the corresponding ketonic amides.—The migration of compounds possessing smell in the plant: Eug. **Charabot** and G. **Laloue.** The migration of these products from the leaves during inflorescence is proved.—The Lutetian in the Soudan and the Sahara: R. **Chudeau.**

DIARY OF SOCIETIES.

THURSDAY, APRIL 25.

ROYAL SOCIETY, at 4.30.—*Croonian Lecture.*—On the Essential Constituents of the Nucleus and their Relation to the Organisation of the Individual: Prof. J. B. Farmer, F.R.S.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Address by the President: T. Hurry Riches.

INSTITUTION OF ELECTRICAL ENGINEERS at 8.—Depreciation Provision on Electricity Supply Undertakings: R. Hammond.

FRIDAY, APRIL 26.

ROYAL INSTITUTION, at 9.—New Illuminants: James Swinburne, F.R.S.

PHYSICAL SOCIETY, at 5.—Electrical Conduction produced by Heating Salts: A. E. Garrett.—The Influence of Pressure upon Convection Currents, and a Criticism of J. Stark's Relation between Cathode Fall of Potential and Temperature: W. S. Tucker.—Solenoids which are turned by the Earth's Magnetic Field: W. B. Croft.—Simple Apparatus for mechanically illustrating the Tangent and Sine Laws: J. A. Tomkins.

SATURDAY, APRIL 27.

ROYAL INSTITUTION, at 3.—Studies in Magnetism: Prof. Silvanus P. Thompson, F.R.S.

MONDAY, APRIL 29.

SOCIETY OF ARTS, at 8.—Detergents and Bleaching Agents used in Laundry Work: Prof. Herbert Jackson.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Polar Problems: Dr. Fridtjof Nansen, G.C.V.O.

INSTITUTE OF ACTUARIES, at 5.—On Extra Premiums: H. E. W. Lutt.

TUESDAY, APRIL 30.

ROYAL INSTITUTION, at 3.—Stimulation, Luminous and Chemical: Prof. William Stirling.

SOCIETY OF ARTS, at 8.—Lustre Pottery: William Burton.

ANTHROPOLOGICAL INSTITUTE, at 8.15.—Lantern Demonstration of Two Contrasted Types of North American Indians: Dr. A. C. Haddon, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Annual General Meeting.

WEDNESDAY, MAY 1.

SOCIETY OF ARTS, at 8.—The Defence of the Sea Coast from Erosion: Alfred E. Carey.

ENTOMOLOGICAL SOCIETY, at 8.

GEOLOGICAL SOCIETY, at 8.—On the Xerophytic Character of Coal-Plants and a Suggested Origin of Coal-Beds: Prof. G. Henslow.—Petrological Notes on the Igneous Rocks lying to the South-East of Dartmoor: H. J. Lowe.

THURSDAY, MAY 2.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—The Spontaneous Crystallisation of Binary Mixtures. Experiments on Salol and Betol: Prof. H. A. Miers, F.R.S., and Miss F. Isaac.—On the Variation of the Pressure developed during the Explosion of Cordite in Closed Vessels: Prof. C. H. Lees, F.R.S., and J. E. Petavel.—Space described in a Given Time by a Projectile moving in Air: A. Mallock, F.R.S.

SOCIETY OF ARTS, at 4.30.—The Applicability to India of Italian Methods of Utilizing Silt: Sir Edward C. Buck, K.C.S.I.

LINNEAN SOCIETY, at 8.—The Fauna and Flora of Abyssinia compared with Those of West Africa: Prof. E. B. Poulton, F.R.S.—(1) Report on the Marine Biology of the Sudanese Red Sea (Communicated with an Introduction by the President); (2) Formation of the Shone Cliff near Alexandria; (3) Recent History of the Coral Reefs of the North-West Shores of the Red Sea: Cyril Crossland.—Polyplacophora collected by Mr. Cyril Crossland: E. R. Sykes.—On Chelonethi (Pseudoscorpions) from Asia and Australia: C. J. With.—Note on the Function of the Spiracle in certain Elasmobranchs: A. D. Darbishire.—*Exhibits*: (1) Probate of the Will of Richard Anthony Salisbury; (2) Manuscripts of Dr. W. J. Burchell, F.L.S., Presented to the University of Oxford by Francis A. Burchell, Esq., Rhodes University College, Grahamstown, Grand-nephew of the Great Naturalist and Explorer: Prof. E. B. Poulton.

CHEMICAL SOCIETY, at 8.30.—(1) The Chemical Action of Exradio, Part I., Action on Distilled Water; (2) The Chemical Action of Exradio, Part II, Action on Copper Salts in Solution. Preliminary Note: Sir W. Ramsay.—Freezing Point Curves of the Menthyl Mandelates: A. Findlay and E. M. Hickmans.—The Constitution of Homo-eriodictyol. A Crystalline Substance from Eriodictyon Leaves: F. B. Power and F. Tutin.—The Relation between Valency and Heats of Combustion. Preliminary note: G. Le Bas.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Use of Wooden Poles for Overhead Power Transmission: C. Wade.

FRIDAY, MAY 3.

ROYAL INSTITUTION, at 9.—Dexterity and the Bend Sinister: Sir James Crichton-Browne, F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Igneous Rocks of the Bristol District: Prof. S. H. Reynolds.—The Carboniferous Limestone Sections of Burrington Combe and Cheddar: T. F. Sibly.—Recent Researches in the Lower Carboniferous Rocks: Dr. A. Vaughan.

SATURDAY, MAY, 4.

ROYAL INSTITUTION, at 3.—Scientific Work in the Sea-Fisheries: Prof. W. C. McIntosh.

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